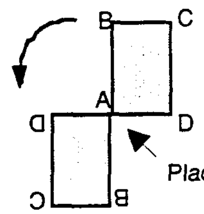
understand that there are three ways to describe the rotation:

1) the amount of the turn (as a fraction or as degrees)
2) the direction of the turn (**clockwise** or **counterclockwise**)
3) the location of the center of rotation

- Have students help describe these three things about the rotation of the triangle on the transparency. (The triangle rotated 1/4 turn (90°). It moved like a clock - clockwise. The center of rotation was point A.)
- Repeat the same steps with the rectangle, rotating it 90° around point A as shown below.



- Have students describe the rotation. (The rectangle turned halfway (180°). It moved opposite of a clock - counterclockwise. The center of rotation was point A.)
- Additional practice with rotation is is provided on the activity sheet Let's Rotate.
- The activity sheets Practice with Slides, Flips, and Turns and Visual Thinking with Transformations can be used for further review of the three transformations learned in this unit.

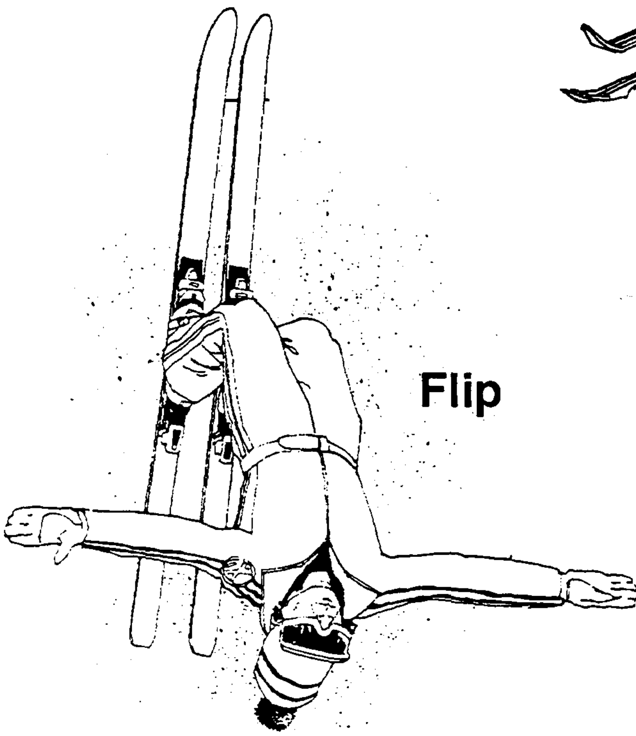
Language Development Activities

- The teacher is encouraged to spend time working with students on the vocabulary in this objective as Obj. 44 is quite language intensive. Working together with the students as they add these words to their vocabulary notebook is a good strategy for vocabulary instruction and retention. The activity sheet Vocabulary Matching will give students an opportunity to review the meaning and usage of this geometric vocabulary.
- Let's Talk Transformations and Symmetry provides students with the opportunity to think and write about symmetry and transformations in a more creative way, using geometric vocabulary to explain and answer questions.

Visualizing a Slide, Flip, and Turn

Transparency

Slide

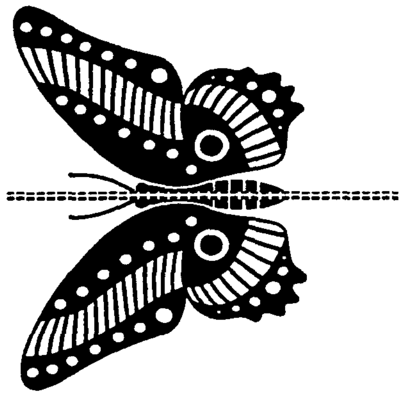


Flip

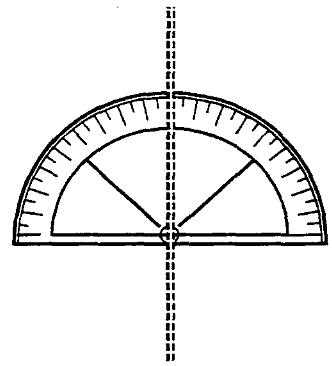
Turn

Transparency

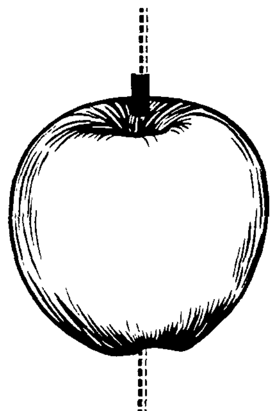
Symmetry
All Around Us



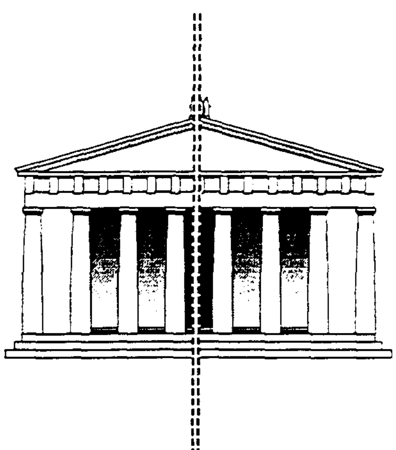
Butterfly



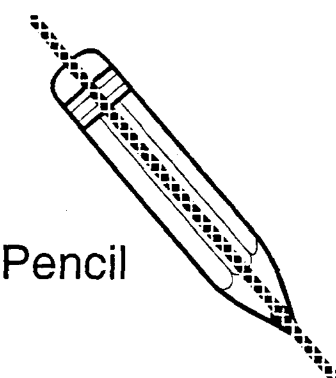
Protractor



Apple



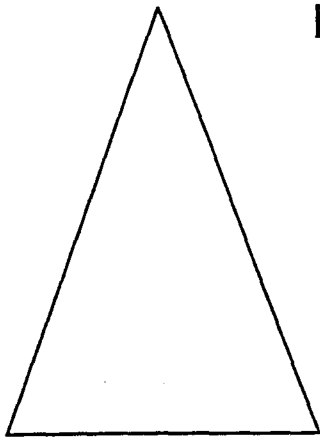
Building



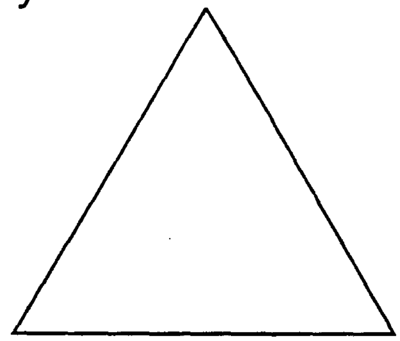
Pencil

Student Copy

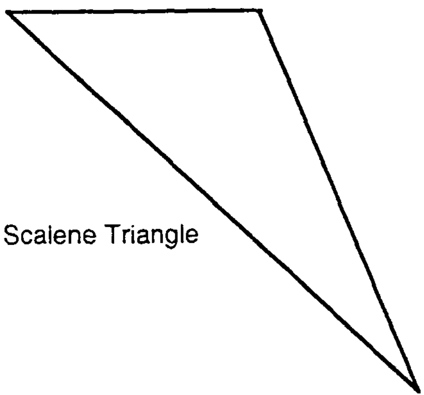
Lines of Symmetry



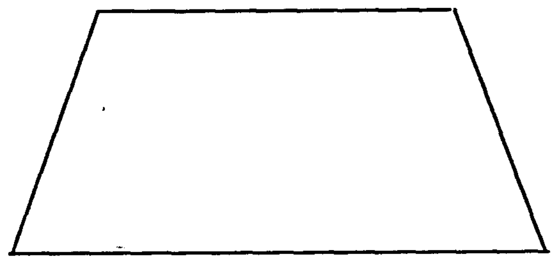
Isosceles Triangle



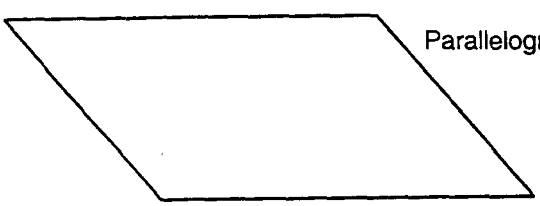
Equilateral Triangle



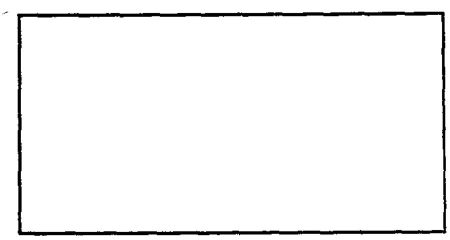
Scalene Triangle



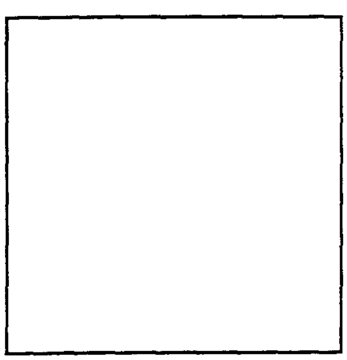
Trapezoid



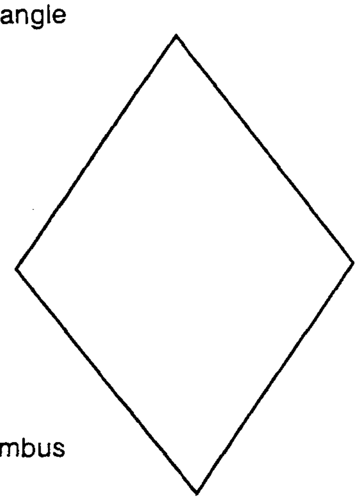
Parallelogram



Rectangle



Square

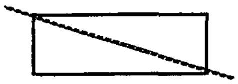


Rhombus

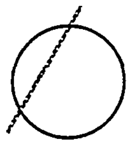
Name: ________________

Symmetry Practice

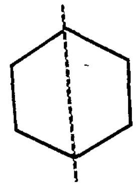
Tell whether the dotted lines are lines of symmetry. (Write yes or no.)



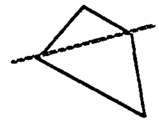
1) ______



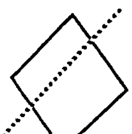
2) ______



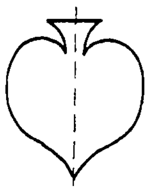
3) ______



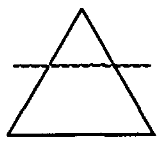
4) ______



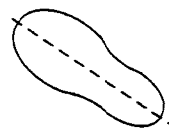
5) ______



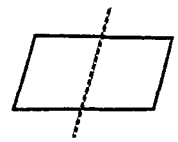
6) ______



7) ______

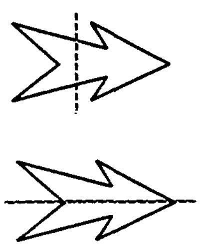


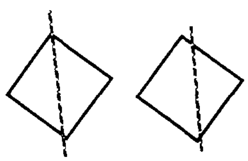
8) ______

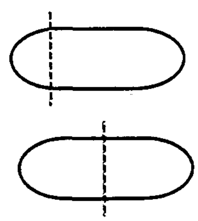


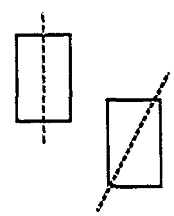
9) ______

Circle the figure in each pair that shows a line of symmetry.

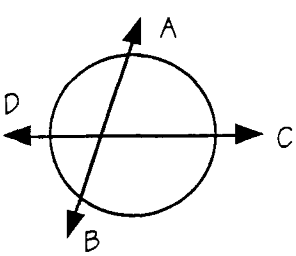
10) 

11) 

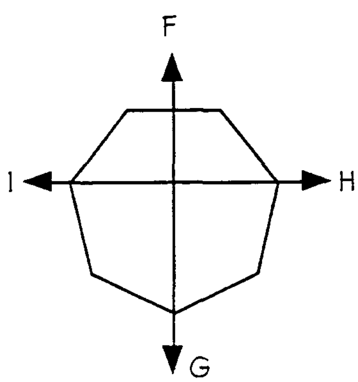
12) 

13) 

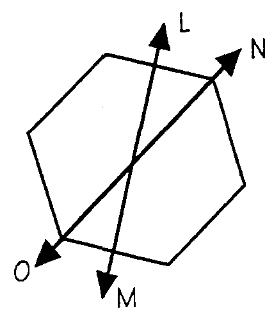
Which are lines of symmetry?



line ______

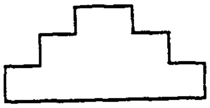


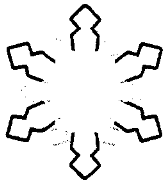
line ______

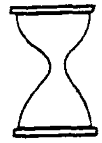


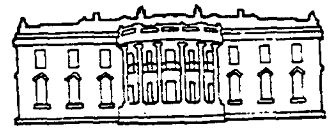
line ______

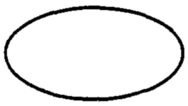
Draw all lines of symmetry.

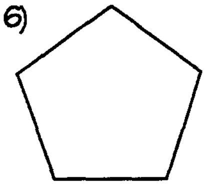
1) 

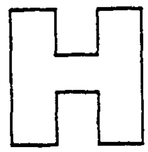
2) 

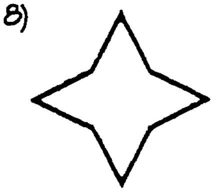
3) 

4) 

5) 

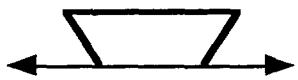
6) 

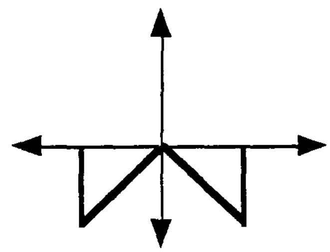
7) 

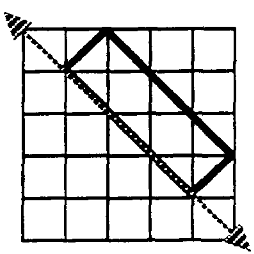
8) 

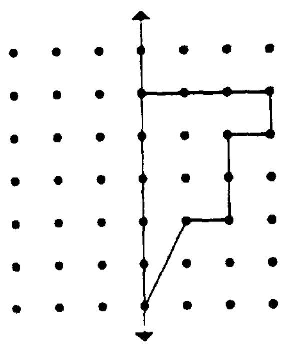
Complete the design to make a symmetrical figure.

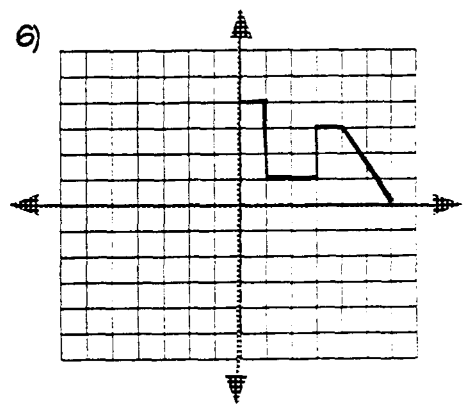
1) 

2) 

3) 

4) 

5) 

6) 

Use the letters to answer the questions.

A B D E H J L M N O P Q S T U V W X Y Z

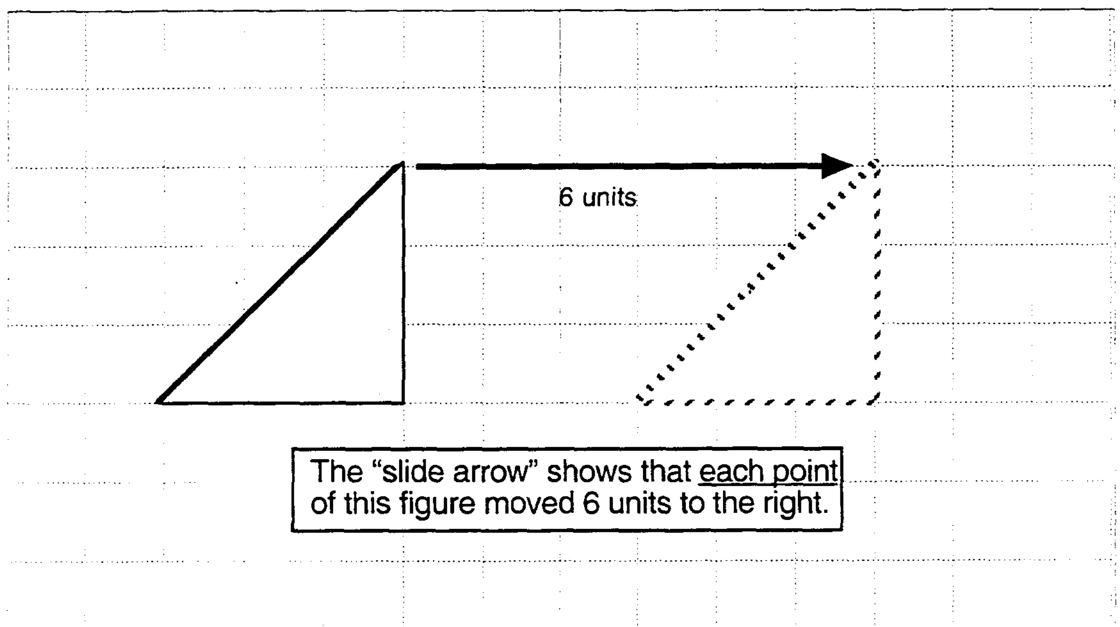
1) Which letters have no lines of symmetry? ______________________________

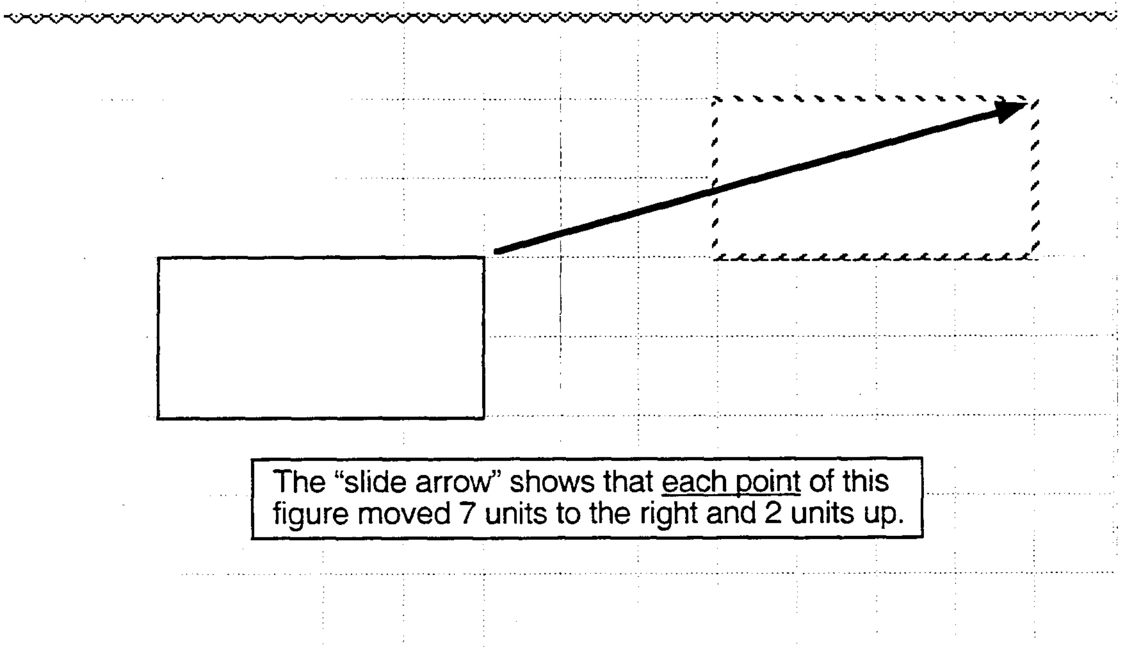
2) Which letters have only one line of symmetry? ______________________________

3) Which letters have more than one line of symmetry? ______________________________

Slide/Translation

A slide is also called a translation. In a translation, every point in the figure slides the same distance in the same direction.

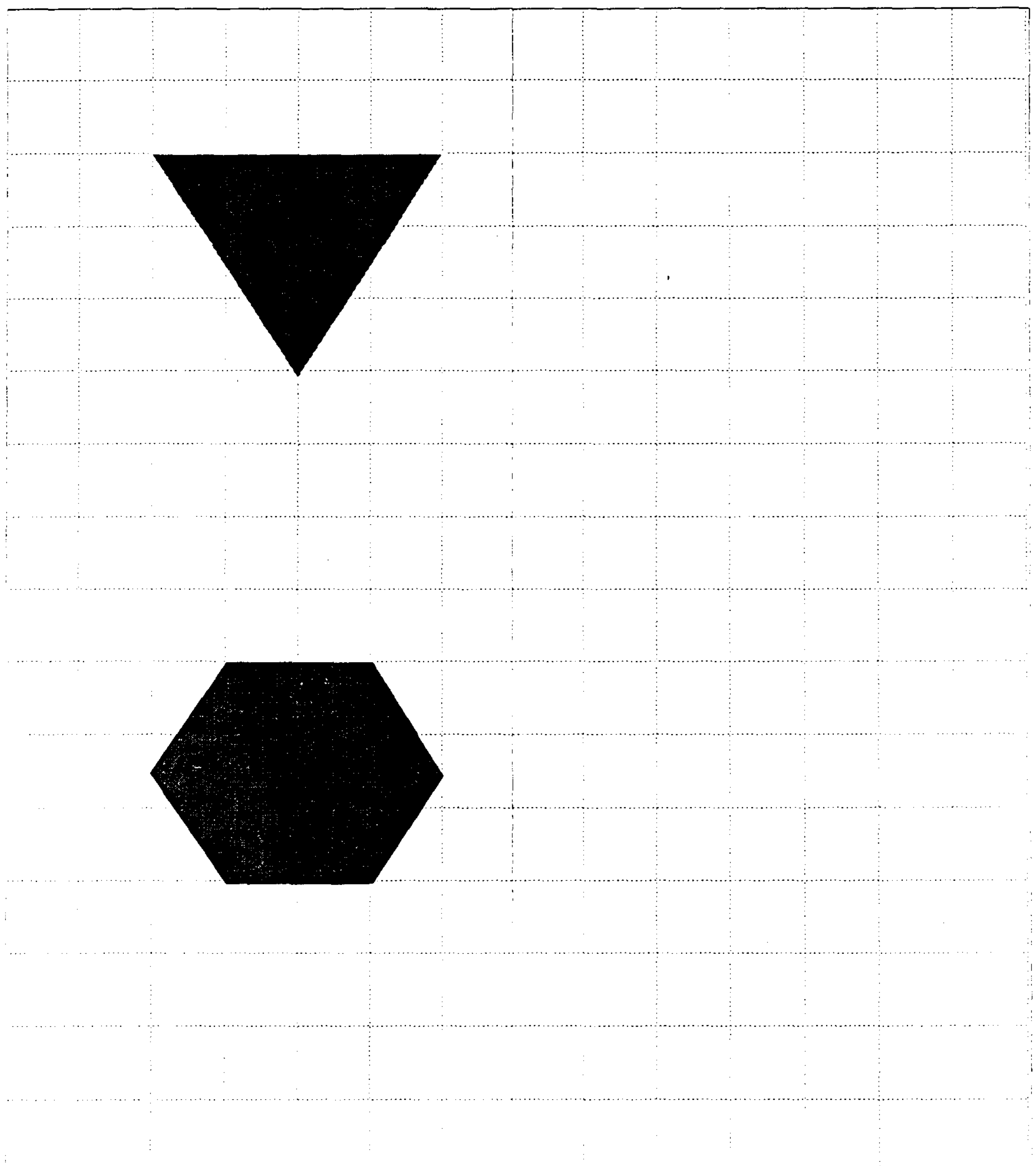




Can You Draw a Translation?

Transparency

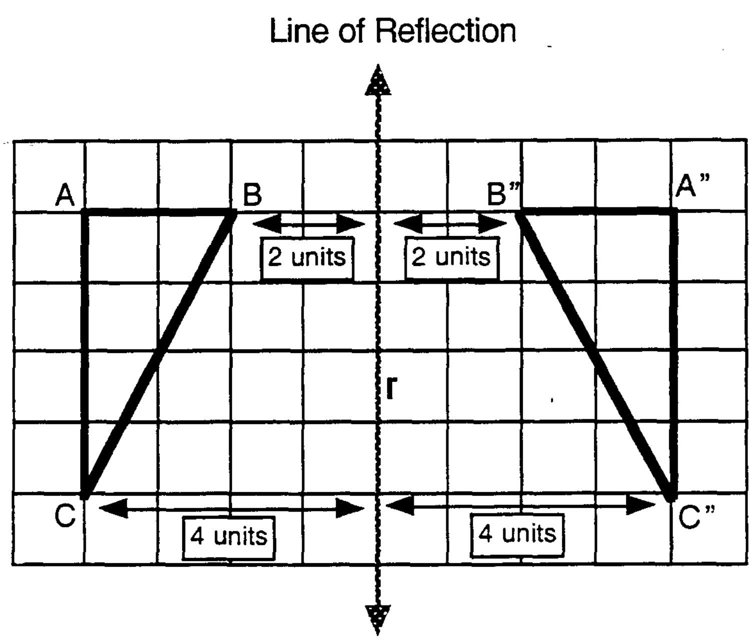
1) Draw a second figure for each polygon to show a translation.
2) Show a translation arrow.
3) Talk with a partner about:
   - *the direction(s) each figure moved (right - left- up - down)*
   - the number of units each figure moved



Transparency / Student Copy

Grid Paper

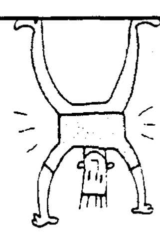
Creating a Reflection



* Draw a polygon on one side of the line of reflection.

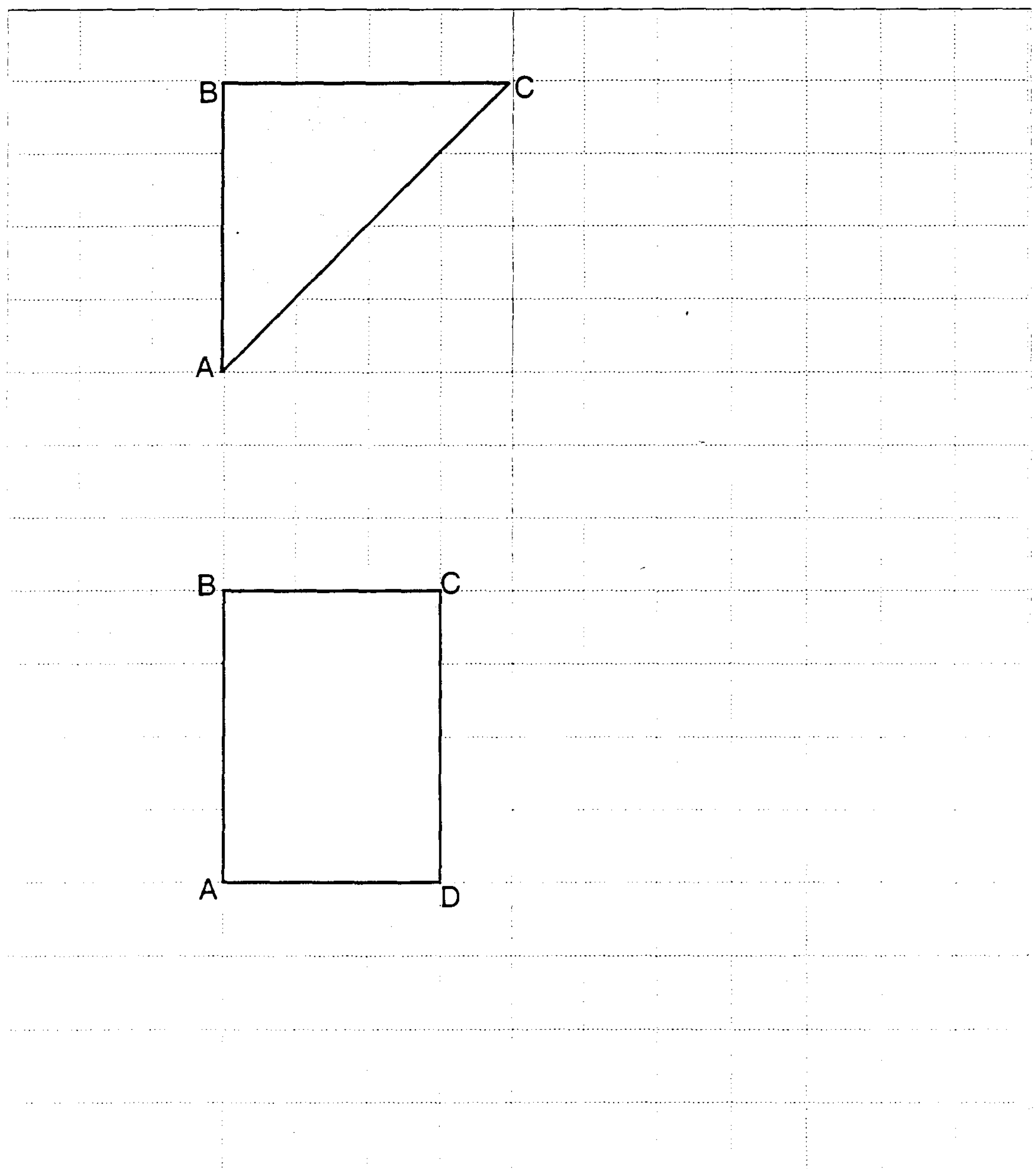
* To draw a reflection, match points on the polygons so they are on opposite sides and the same distance from the line of reflection.

Points B and B" are both 2 units from line r.
Points A and A" are both 4 units from line r.
Points C and C" are both 4 units from line r.



Exploring Rotation

A turn is also called a **rotation**. In geometry, rotation is when a figure turns around a center point.

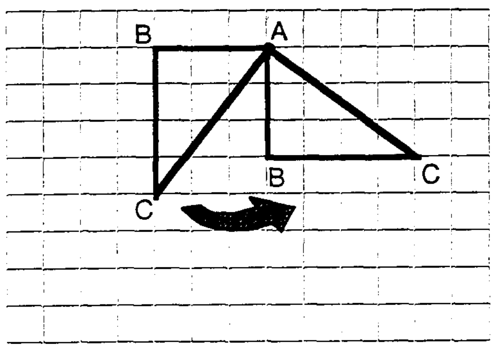


Name: ________________

Let's Rotate

Remember!
3 ways to describe a rotation are:
1) amount of turn
2) direction
3) point of rotation

1)



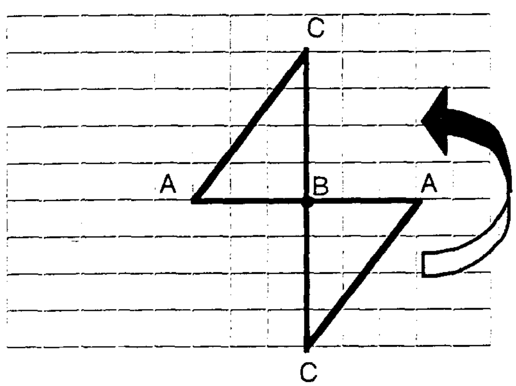
Describe the rotation 3 ways:

1) ______________________

2) ______________________

3) ______________________

2)



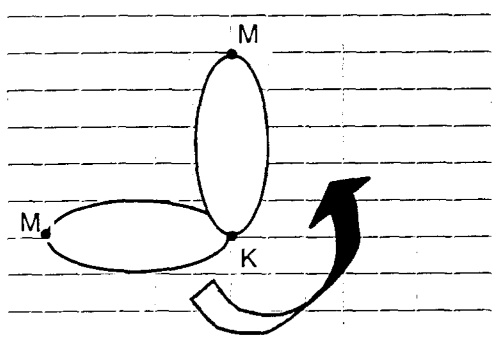
Describe the rotation 3 ways:

1) ______________________

2) ______________________

3) ______________________

3)



Describe the rotation 3 ways:

1) ______________________

2) ______________________

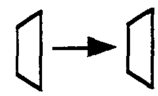
3) ______________________

Name: ____________________

Practice with Slides, Flips, and Turns

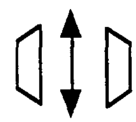
You can **slide** the figure up, down, right, or left.
The figure looks the same, but is in a different place.

Translation



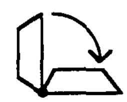
You can **flip** a figure over a line of reflection.
The figure has a mirror image.

Reflection

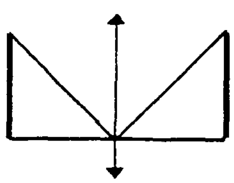


You can **turn** a figure on a point.
The point acts like a pin when you turn the figure.

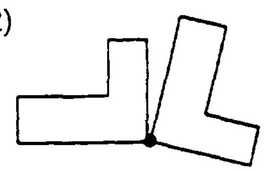
Rotation



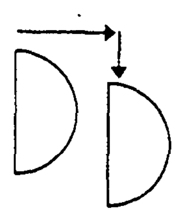
Write **slide**, **flip**, or **turn** to show how each figure was moved.

1) 

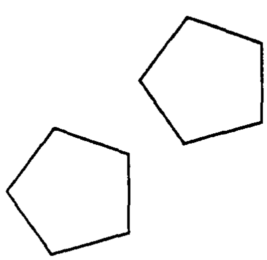
____

2) 

____

3) 

____

4) 

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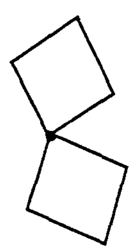
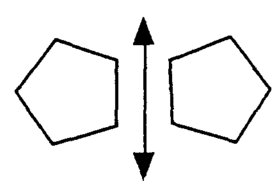
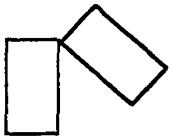
5) 

____

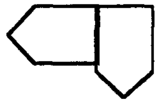
6) 

____

Look at the word below each figure. Write **<u>true</u>** or **<u>false</u>** .

1) 

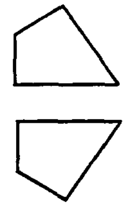
Rotation ______

2) 

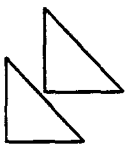
Reflection ______

3) 

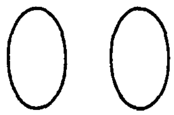
Translation ______

4) 

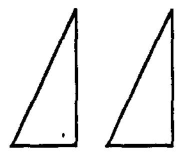
Reflection ______

5) 

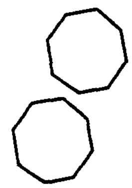
Reflection ______

6) 

Rotation ______

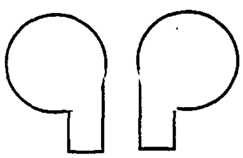
7) 

Reflection ______

8) 

Translation ______

Tell whether the figure is a **translation**, a **rotation**, or a **reflection**.

1) 

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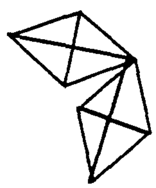
2) 

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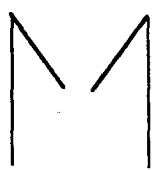
3) 

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4) 

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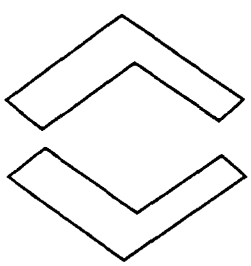
5) 

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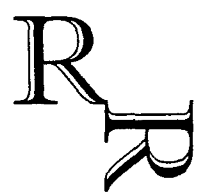
6) 

____

7) 

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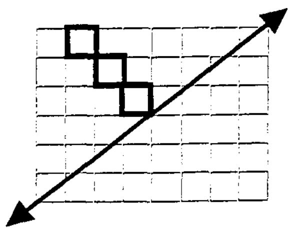
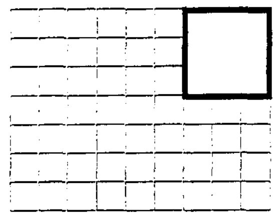
Name: ________________

Visual Thinking with Transformations

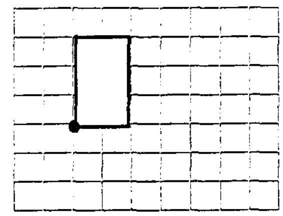
Draw a reflection.



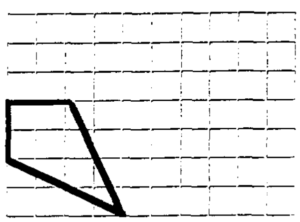
Draw a slide of this figure left 5 units and down 2 units



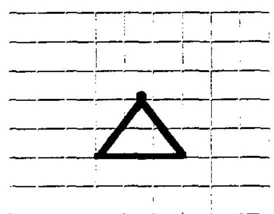
Rotate the figure around the point. Draw the new figure



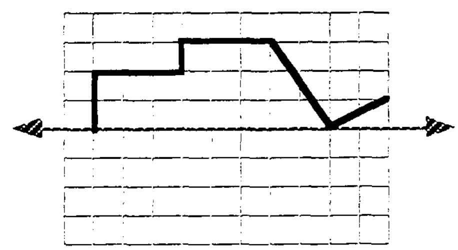
Draw the slide figure that is 6 right and 2 up.



Draw a rotation of this figure.



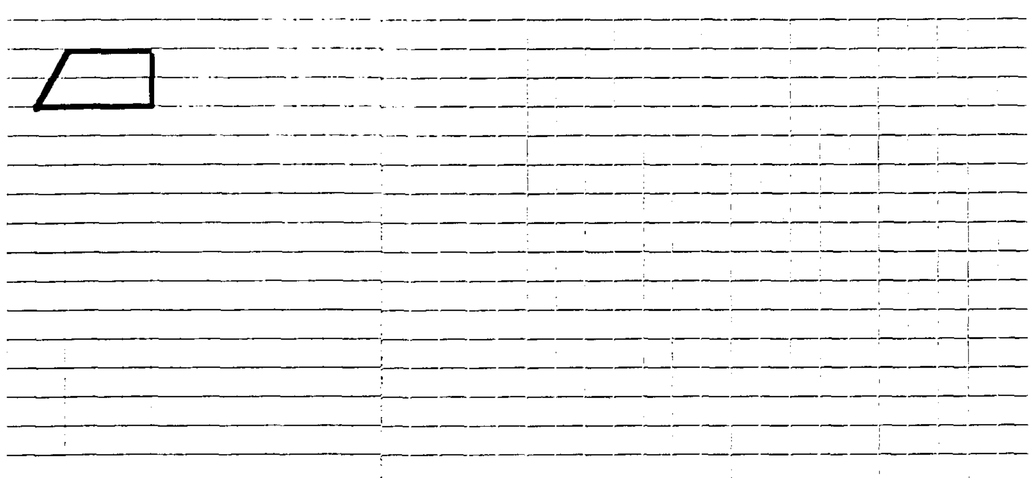
Draw a flip image.



Draw and label a slide, flip, and turn for figure # 1, then do the same for a figure of <u>your own</u> (#2).

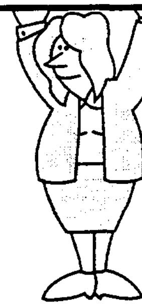
1)

2)



Name: ______________

Vocabulary Match



___ 1) symmetry

___ 2) slide

___ 3) clockwise

___ 4) transformation

___ 5) line of reflection

___ 6) rotation

___ 7) counterclockwise

___ 8) line of symmetry

___ 9) flip

___ 10) polygon

A. reflection

B. a figure that is changed by moving it

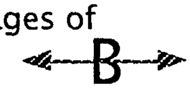
C. translation

D. a closed figure formed from line segments

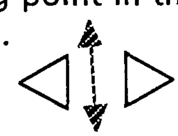
E. when a figure is folded, it has two parts that match exactly

F. the direction that the hands of the clock move (12, 1, 2 , 3..)

G. a fold line that divides a figure into two congruent halves, mirror images of each other



H. a figure is flipped over this line - each point is the same distance from the line as the corresponding point in the original shape.



I. the opposite direction that the hands of a clock move (11, 10, 9, 8...)

J. turn

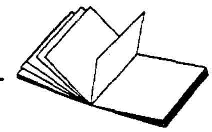
Name:________________

Let's Talk Transformations and Symmetry

Use FLIP, SLIDE, or TURN to answer each question.
Which transformation motion do you use when you do these things?

1) zip a jacket ______________

2) turn a page in a book ______________



3) open a jar of peanut butter ______________

4) screw in a light bulb ______________

5) Name and draw 3 things in your classroom that have symmetry.

6) Is the human body symmetrical? Explain your answer.

7) Do all figures have a line of symmetry? If not, name such a figure.

8) Can a figure have more than one line of symmetry? If yes, name such a figure.

Answer Key
Obj.44

Symmetry Practice - p.10

<u>Tell whether the dotted lines are lines of symmetry. Write yes or no.</u>

1) no 2) no 3) yes 4) no
5) no 6) yes 7) no 8) yes 9) no

<u>Circle the figure that shows lines of symmetry.</u>

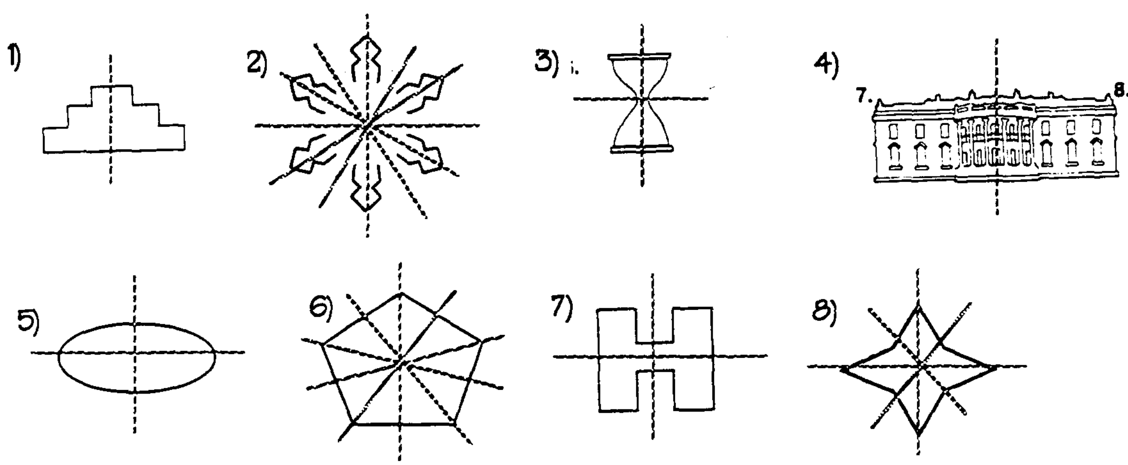
10) bottom figure 11) left figure 12) bottom figure 13) top left figure

<u>Which are lines of symmetry?</u>

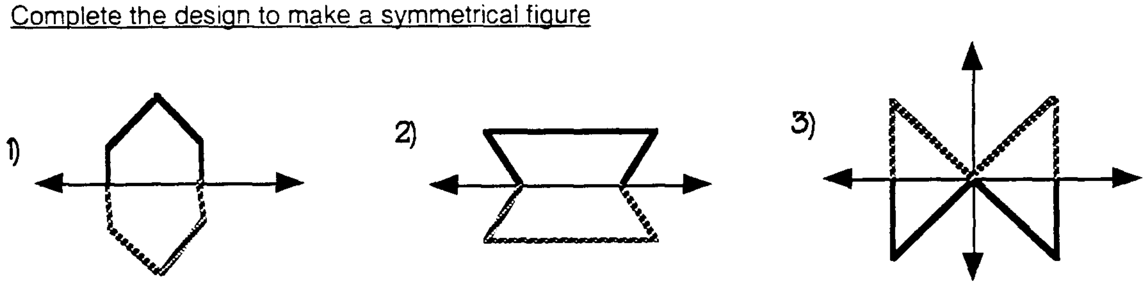
line CD; line FG; line ON <u>and</u> line LM

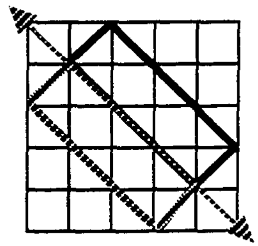
Symmetry Practice p.11

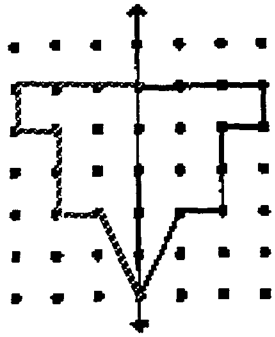
<u>Draw all lines of symmetry.</u>

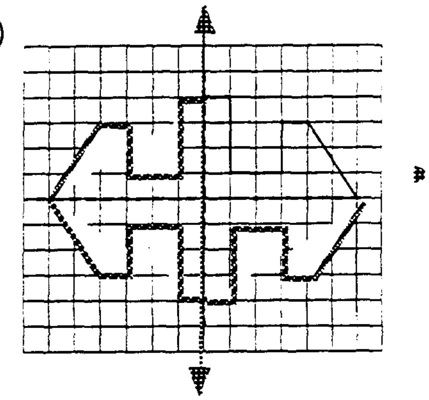


<u>Complete the design to make a symmetrical figure</u>



4) 

5) 

6) 

Use the letters to answer the questions.

1) Which letters have no lines of symmetry? **J L N P Q S Z**

2) Which letters have only one line of symmetry? **A B D E T U V W Y**

3) Which letters have more than one line of symmetry? **H O X**

Let's Rotate

1) 90° ; clockwise; Point A
2) 180°; counterclockwise; Point B
3) 270°; counterclockwise; Point K

Practice with Slides, Flips, and Turns

1) flip	2) turn	3) slide
4) slide	5) turn	6) flip

Look at the word below each figure. Write True or False.

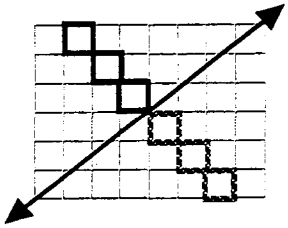
1) True	2) False	3) True	4) True
5) False	6) False	7) False	8) True

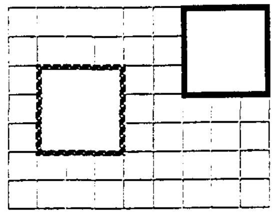
Tell whether the figure is a translation, rotation, or reflection.

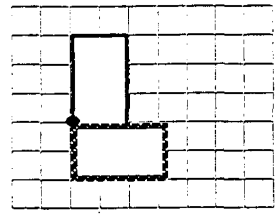
1) reflection	2) rotation	3) reflection	4) translation
5) reflection	6) translation	7) rotation	

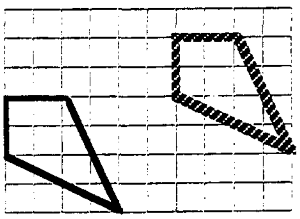
Visual Thinking with Transformations

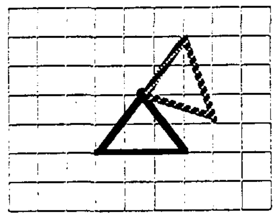
Possible answer.
Answers will vary.

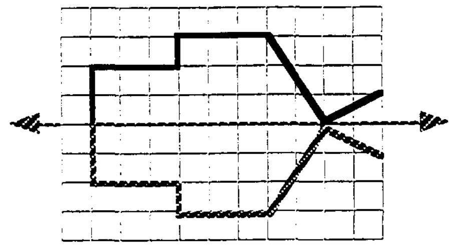












Draw and label a slide, flip, and turn. - Answers will vary.

Vocabulary Match

1) E	6) J
2) C	7) I
3) F	8) G
4) B	9) A
5) H	10) D

Let's Talk Transformations and Symmetry

1) slide
2) flip
3) turn
4) turn
5) answers will vary
6) Yes, a line can be drawn down the middle of the body.
7) No, a hand would not be symmetrical - the fingers aren't mirror images; many styles of scissors are not symmetrical.
8) Yes, a hexagon, a circle, a square, ... etc.

Objective 45: Explore congruent and similar geometric figures. Write proportions to express similar relationships and solve for unknown sides.

Vocabulary

polygon
match
congruent
similar
ratio
proportion
corresponding sides
corresponding angles
prove/proof

Materials

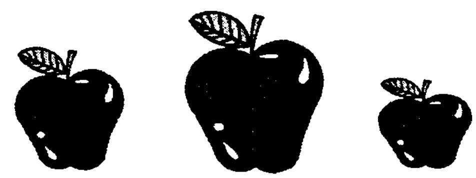
Pattern blocks
overhead and student sets

Transparencies:
Comparing Polygons
Similar Triangles
Congruent and Similar Figures
wall poster

Student Copies:
Congruent Figures
Congruent Polygons
Building Similar Figures
Similar Figures
Working With Similar Figures
Find the Missing Side
Vocabulary Practice - Congruent and Similar Figures

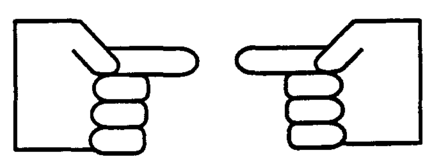
Language Foundation

1. Point out the difference between the words **similar** and **congruent.** In this case, explain that similar means that two things are alike in some way, but they are not exactly the same. These three apples have the same shape, but are different sizes. These figures are similar.



On the other hand, when something is congruent to something else, it is exactly the same. These apples are congruent.

2. Use the fingers on your hands in the following example to explain the meaning of corresponding: the fingers that are in the same position or place are **corresponding**.

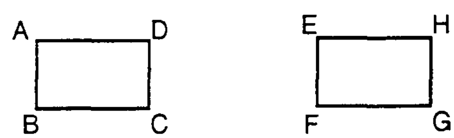


3. Students will need to understand the verb **prove** and the noun **proof.** Ask students to prove that they did their homework last night. They can do this by showing you the completed assignment. Tell them when they show it to you that this is the proof or evidence that it was done.

In court, lawyers have to prove that something is true or not true. They must show evidence or proof to make their case.

Mathematics Component

1. Develop the concept of congruent figures.
   - Display the <u>Comparing Polygons</u> transparency on the overhead, covering Side 2 with a piece of paper. (Remind students that a polygon is a closed figure formed from line segments.)
   - Point to Side 1 and ask students what they notice about the two figures. (Responses should include but are not limited to the following: both are rectangles, both are the same size.)
   - Tell students that if two figures have the same shape <u>and</u> size they are called **congruent.**
   - Explain that if two figures are congruent, they can be placed one on top of the other and they will **match** exactly. Use a clean transparency to trace over one of the rectangles and then place it over the second rectangle to show that they match. Say, "The figures **match** exactly. The figures are **congruent.**"
   - Tell students that there is a special symbol that is used to show that two figures are congruent. Write the following below the two rectangles as you say, "Rectangle ABCD <u>is congruent to</u> rectangle EFGH." Remind students that rectangles are named using the four vertices. (The vertices are the four points where the sides of the rectangle meet.)



ABCD $\cong$ EFGH

This symbol is read **"is congruent to."**

   - Point to line segment AB on the first rectangle and ask students which line segment is in the same position, or place, in the second rectangle. (Line segment EF is in the same position as line segment AB.)
   - Explain that line segments which are in the <u>same position</u>, or place, are called **corresponding sides**. Ask students to help you make a list of the corresponding sides on the transparency:

$\overline{AB}$ and $\overline{EF}$
$\overline{CD}$ and $\overline{GH}$
$\overline{BC}$ and $\overline{FG}$
$\overline{AD}$ and $\overline{EH}$

Review the symbol (a straight line) used to name a line segment. This is read "line segment EF."

   - Point to angle A in the first rectangle and ask students to name the angle which is in the same position in the second rectangle. (Angle A and angle E are in the same position.)
   - Tell students that angles which are in the <u>same position</u> are called **corresponding angles**. Ask students to help you make a list of the corresponding angles on the transparency:

$\angle$A and $\angle$E
$\angle$B and $\angle$F
$\angle$C and $\angle$G
$\angle$D and $\angle$H

Review the symbol ($\angle$) used to name an angle. This is read "angle E."

- The activity sheets Congruent Figures and Congruent Polygons provide further practice.

2. Develop the concept of similar figures.
   - Uncover Side 2 of the transparency and ask students what they notice about these two figures. (Responses should include but are not limited to the following: both are rectangles, one is bigger than the other, one is smaller than the other.)
   - Tell the students that they just described the ideas behind "similar" shapes.
   - Discuss the word **similar** in every day terms (alike) and in mathematical terms (same shape, different size)
   - Show students that the symbol for **similar** is ~ .
   - Say, "ABCD is similar to EFGH." Write "ABCD ~ EFGH" below the rectangles on the transparency.
   - Explain that we can prove that shapes are mathematically similar using ratios which compare corresponding sides.
   - Review the definition of **ratios** (a comparison of two things) and corresponding sides (sides which are in the same position or place). Also review that ratios can be written in three ways: 2/3, 2:3 or 2 to 3. Each is read the same way "two to three".
   - Ask the students to identify sets of corresponding sides on the two **similar** (same shape, different size) rectangles on Side 2. (AB and EF, BC and FG, CD and GH, DA and HE)
   - Demonstrate setting up a ratio for each set of corresponding sides.

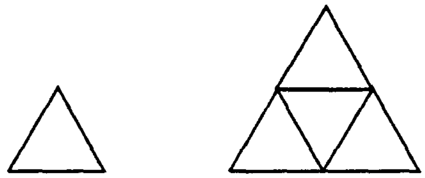
$$\frac{AB}{EF} = \frac{6}{3} = \frac{2}{1} \qquad \frac{BC}{FG} = \frac{4}{2} = \frac{2}{1} \qquad \frac{CD}{GH} = \frac{6}{3} = \frac{2}{1} \qquad \frac{DA}{HE} = \frac{4}{2} = \frac{2}{1}$$

   - Ask students what they notice about each of the ratios for the corresponding sides. (They are all equal)
   - Tell students that the ratios of corresponding sides in all similar figures will always be equal.

   Note: Students may have noticed that with similar rectangles it is only necessary to find the ratio of two sides since opposite sides are the same length in rectangles.

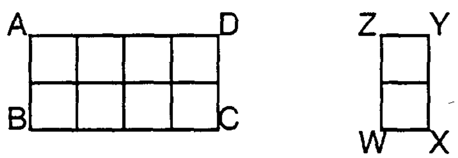
3. In this activity, students will use pattern blocks to build sets of similar figures.
   - Give each pair of students a variety of pattern blocks which include squares, triangles, rectangles, and rhombuses (or rhombi) and the activity sheet Building Similar Figures.
   - Students should separate the pattern blocks by shape (square, triangle, rectangle, rhombus).
   - Have students place one triangle piece in front of them on the desk. Ask how they can use the other triangle pieces to build a figure **similar** to the first triangle. Remind students that similar means same shape, different size, with the ratios of corresponding sides equal. Allow time for students to explore and then share their results on the overhead.

Sample : Similar Triangles with a ratio of 1:2



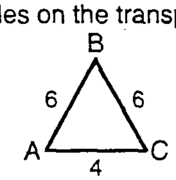
- Demonstrate and then have students sketch the solution on the activity sheet.
- Tell students that they will work with a partner to do the same thing with each of the other shapes. They will place one of each shape in front of them and then build a similar shape using additional pieces. Once they have found a similar shape, ask them to sketch their results on the activity sheet. As students work, circulate around the room asking students to "prove" their figures are similar. Students should be able to tell you the ratio of the corresponding sides.
- When all pairs have completed the activity, ask different pairs to come up and show their results using overhead pattern blocks. Ask the class if they can use ratios to prove whether each solution is a similar figure. (Ratios of corresponding sides will be equal if the figures are similar.)
- The activity sheet Similar Figures can be completed for more practice.

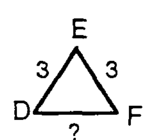
4. In this activity, students will identify corresponding sides in figures which have different orientations.
   - Create the two similar figures below.



   - Be sure students understand that sometimes similar figures may be flipped or turned and they must be careful to find the right corresponding sides before making ratios. (Sides AB and WX are corresponding and have a 2:1 ratio. Sides BC and XY are corresponding and have a 4:2 or 2:1 ratio.) Ask students if the two figures are similar. Ask for proof.
   - Additional practice identifying corresponding sides in figures with different orientations is provided on the activity sheet Working With Similar Figures.

5. Place the transparency Similar Triangles on the overhead.
   - Name the two triangles on the transparency, reviewing the symbol used for triangles (Δ).





Δ ABC ↓ Say, "Triangle ABC."

Δ DEF ↓ Say, "Triangle DEF."

- Have students look at the sides of the two **similar** triangles. Ask if anyone thinks they know the length of the side with the question mark on the smaller triangle. (The side would be 2.)
- If a student answers correctly, ask them to explain why they think it is 2. (The ratios of corresponding sides are always equal on similar triangles. $\frac{AB}{DE} = \frac{6}{3} = \frac{2}{1}$ so $\frac{AC}{DF} = \frac{4}{2} = \frac{2}{1}$)
- Tell students that since the ratios of corresponding sides must be equal on similar figures, we can use the sides which are given and set up a proportion to find the unknown sides. Remind students that a **proportion** is two equal ratios.
- Demonstrate solving a proportion to find DF in the smaller triangle above.

AB, AC

DE, DF

$$\frac{6}{3} = \frac{4}{x}$$

$$4 \cdot 3 = 6 \cdot x$$

$$12 = 6x$$

$$\frac{12}{6} = x$$

$$2 = x$$

Students cross-multiply to set up an equation and then solve for x.

- On the transparency, use the part Solving Proportions with Similar Figures to model other examples to help students become comfortable with this procedure.

Example 1: $\frac{8}{24} = \frac{10}{x}$

$8x = 240$

$x = 30$

Example 2: $\frac{18}{36} = \frac{22}{x}$

$18x = 792$

$x = 44$

- Have students complete the activity sheet Find the Missing Side to practice setting up and solving proportions.

Note: A transparency master/wall poster, Congruent and Similar Figures, is included for review and reinforcement of these concepts.

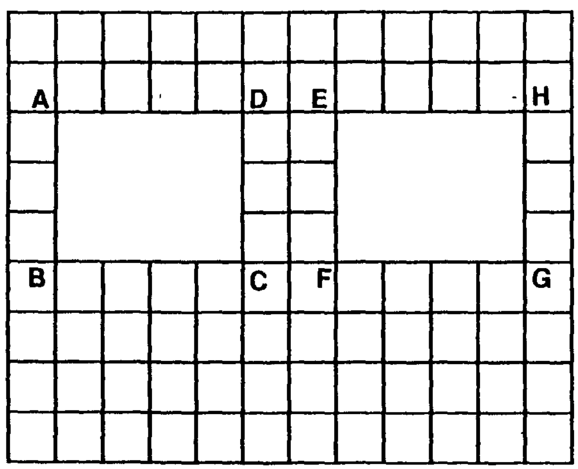
Language Development Activities

- Bring in objects that represent similar and congruent figures such as cans of soup, beans, tomato paste; and boxes of items such as tea, crackers, cereal. Hold up objects or ask students to choose two objects and have them explain whether they are congruent or similar. Both ways will give students oral practice using the vocabulary.
- Have students complete Vocabulary Practice - Congruent and Similar Figures. Make a transparency copy to use prior to beginning the lesson as a format for previewing vocabulary. Students could complete the page by taking notes as the vocabulary is introduced.

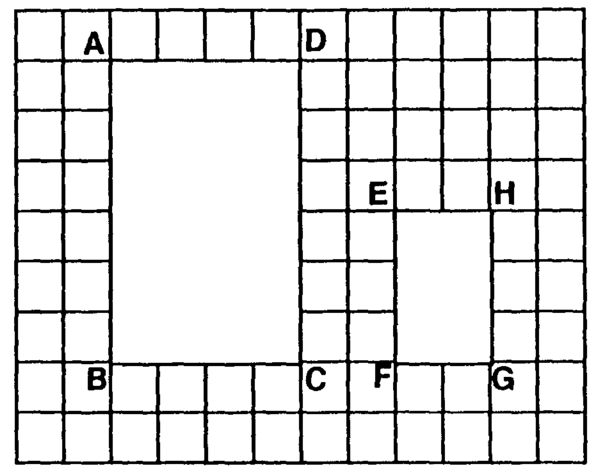
Transparency

Comparing Polygons

Side 1



Side 2



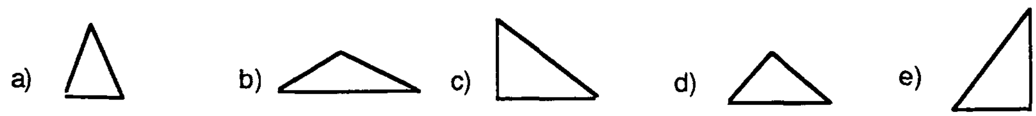
Name:_______________________

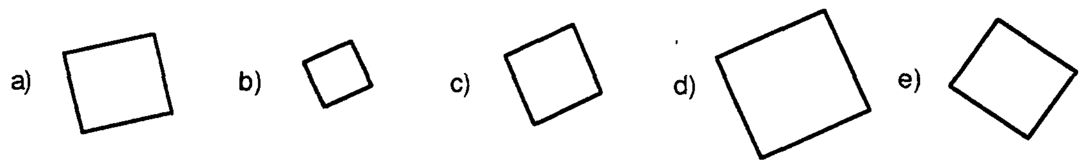
Remember:
Congruent figures are the **same size** and **shape**.

Congruent Figures

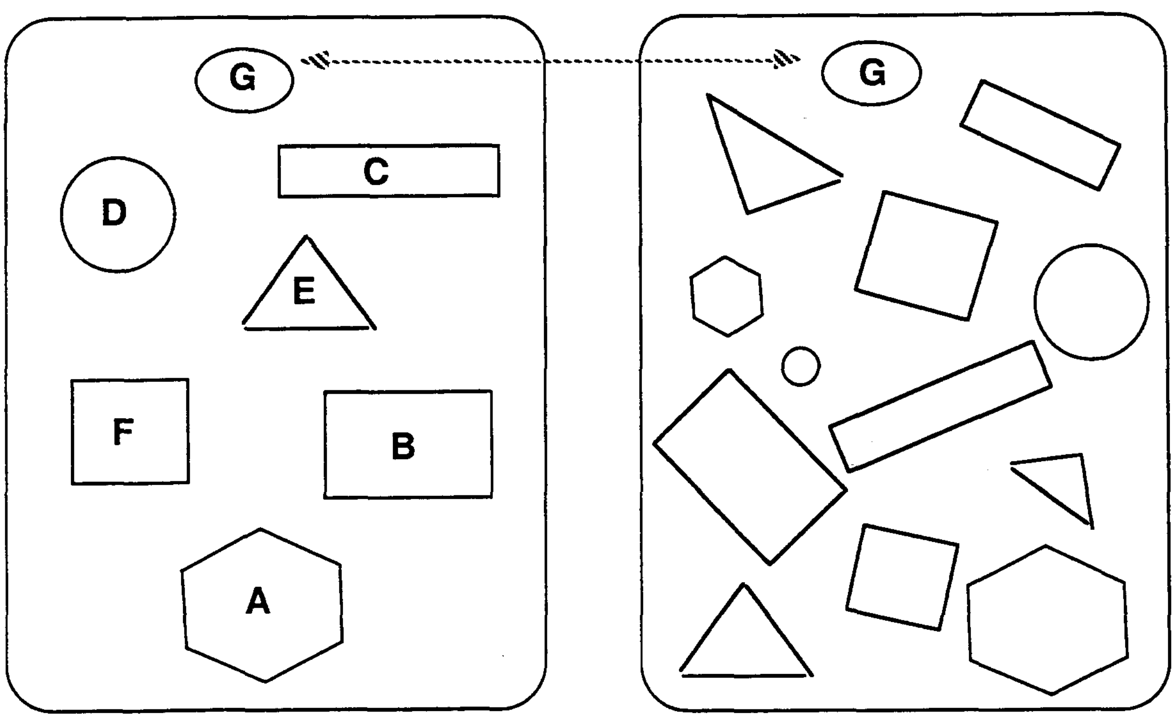
Circle the two figures in each row that are congruent:

1) 

2) 

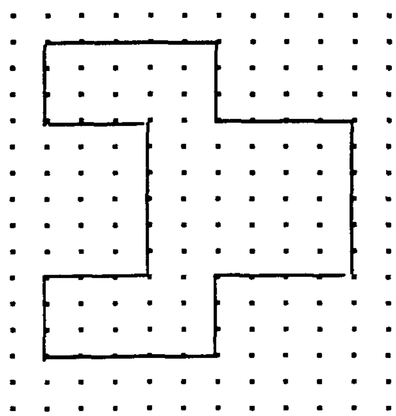
3) 

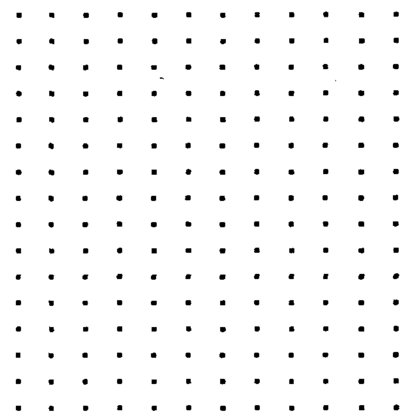
Match up the congruent figures.

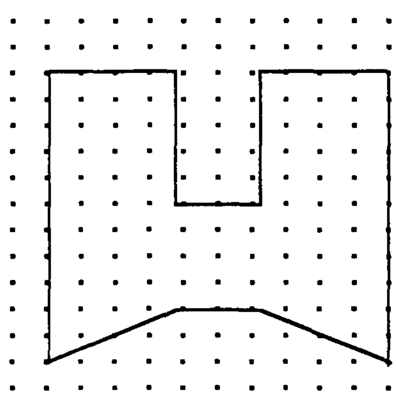


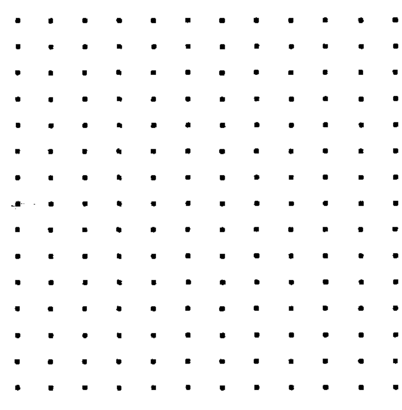
Congruent Figures

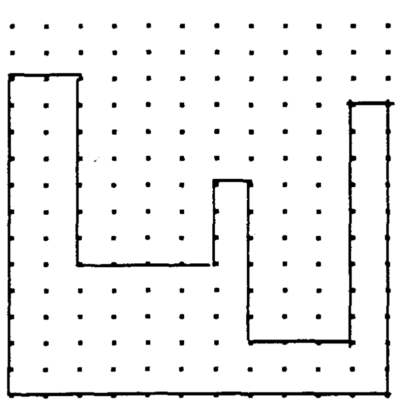
Can you draw a figure congruent to these figures?

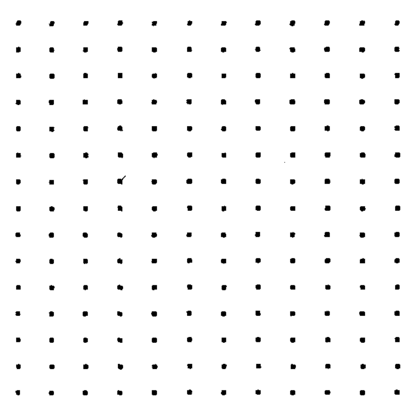










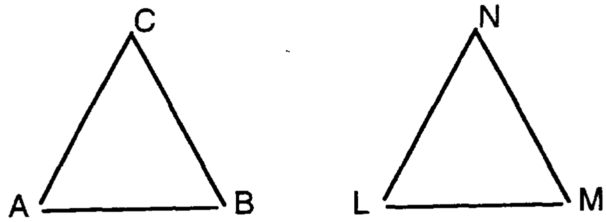


Name:________________

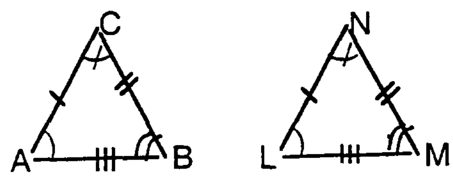
Congruent Polygons

Congruent polygons are the same size and shape.
If you cut out the figures, one could fit exactly on top of the other $\triangle ABC \cong \triangle LMN$

<u>Corresponding Angles</u>	<u>Corresponding Sides</u>
$\angle A \cong \angle L$	$\overline{AB} \cong \overline{LM}$
$\angle B \cong \angle M$	$\overline{BC} \cong \overline{MN}$
$\angle C \cong \angle N$	$\overline{CA} \cong \overline{NL}$

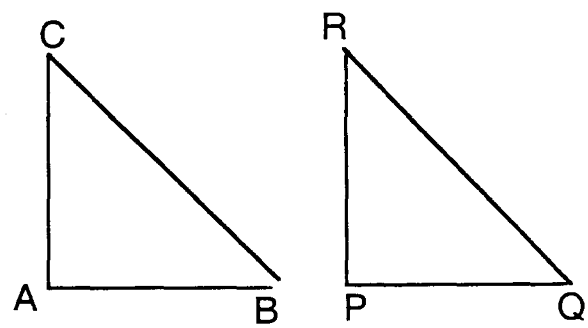


Marks on each polygon show the sides and angles that are congruent.



<u>Complete.</u>

$\triangle ABC \cong \triangle PQR$



1) $\overline{AC} \cong$ ______ 4) $\angle P \cong$ ______

2) $\overline{PQ} \cong$ ______ 5) $\angle C \cong$ ______

3) $\overline{RQ} \cong$ ______ 6) $\angle B \cong$ ______

7) If $\angle Q = 48°$, then $\angle B =$ ______

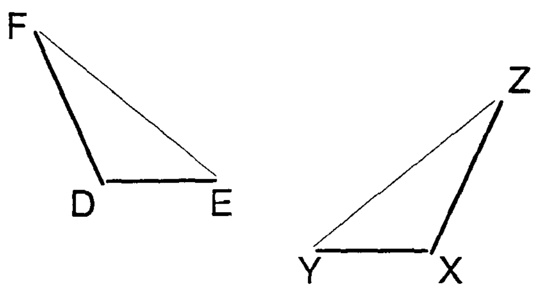
8) If $\angle C = 32°$, then $\angle R =$ ______

9) If $\overline{BC} =$ 19 feet, then $\overline{QR} =$ ______

10) If $\overline{AC} =$ 11 feet, then $\overline{PR} =$ ______

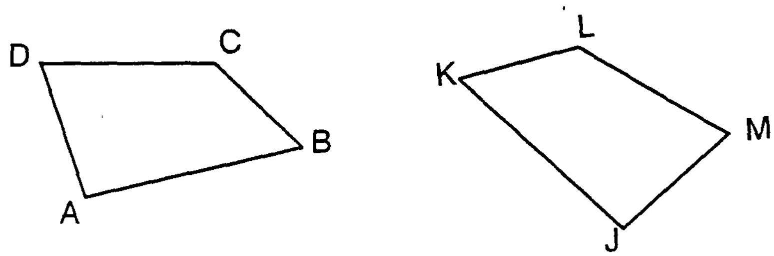
Congruent Polygons

<u>Fill in the blanks with the corresponding congruent parts.</u> $\triangle DEF \cong \triangle XYZ$



1) $\overline{EF} \cong$ ______
2) $\overline{DE} \cong$ ______
3) $\overline{FD} \cong$ ______
4) $\angle Y \cong$ ______
5) $\angle Z \cong$ ______
6) $\angle X \cong$ ______

<u>Find the corresponding sides and angles .</u> Quadrilateral ABCD $\cong$ JKLM



1) $\overline{AB} \cong$ ______
2) $\overline{BC} \cong$ ______
3) $\overline{CD} \cong$ ______
4) $\overline{DA} \cong$ ______
5) $\angle M \cong$ ______
6) $\angle K \cong$ ______
7) $\angle J \cong$ ______
8) $\angle L \cong$ ______

<u>Draw two corresponding figures. Label them.</u>
<u>Find pairs of corresponding sides and pairs of corresponding angles.</u>

Figure 1

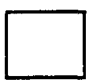
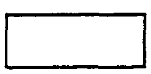
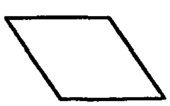
Figure 2

<u>Corresponding Sides</u>

<u>Corresponding Angles</u>

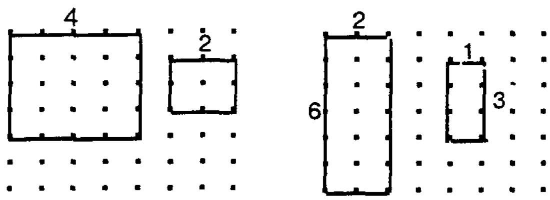
Name: ______________________

Building Similar Figures

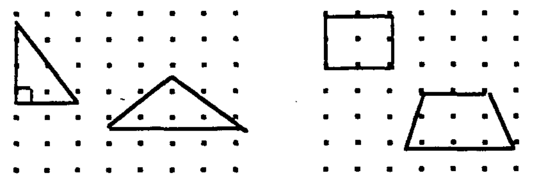
Figure	Draw a similar figure
	
	
	
	

Name: ____________________

Similar Figures



These figures are similar.

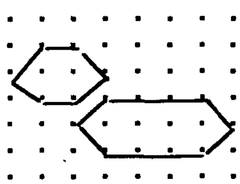


These figures are NOT similar.

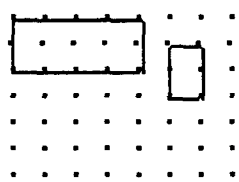
Similar Polygons have:

1) Corresponding angles congruent
2) Corresponding sides in proportion.
   Their lengths have the same ratio. $\frac{4}{4} = \frac{2}{2}$ and $\frac{2}{6} = \frac{1}{3}$

Are these figures similar? Write yes or no.



____



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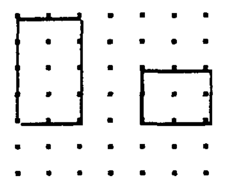

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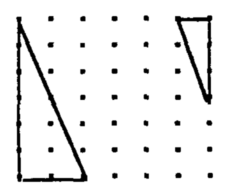
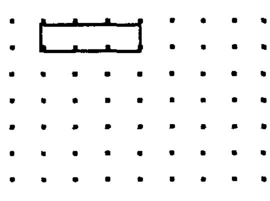
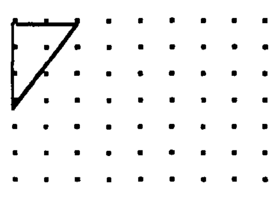
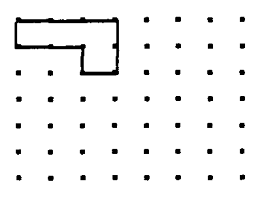


____

Draw a similar figure. **Double** the length of each side.







Name: ____________________________

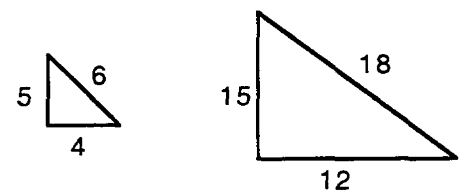
Working with Similar Figures

Fill in with the corresponding proportional side. The triangles are similar.

1) 4 ft. corresponds to ________ ft.

2) 5 ft. corresponds to ________ ft.

3) 6 ft. corresponds to ________ ft.



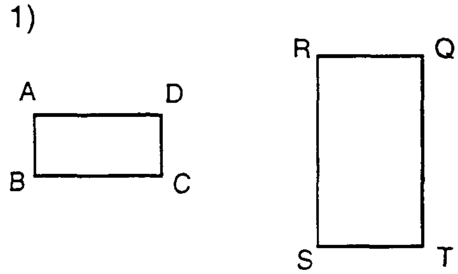
1) $\frac{4}{12} = \frac{\_\_\_}{15}$ 2) $\frac{6}{18} = \frac{4}{\_\_\_}$ 3) $\frac{15}{5} = \frac{\_\_\_}{6}$

What is the ratio of the corresponding sides of these two triangles? ________________

More Practice with Similar Figures

Match up the corresponding sides. Be careful! The figures are turned in different positions.

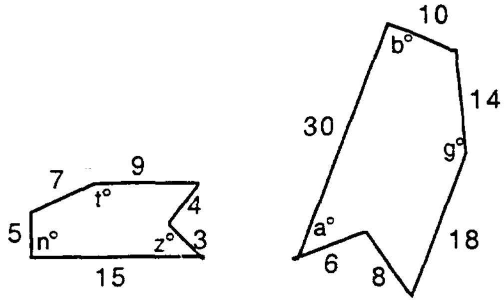
1)



$\overline{ST}$ corresponds to ________

$\overline{RS}$ corresponds to ________

2)



5 corresponds to ________

3 corresponds to ________

30 corresponds to ________

8 corresponds to ________

14 corresponds to ________

n° corresponds to ________

z° corresponds to ________

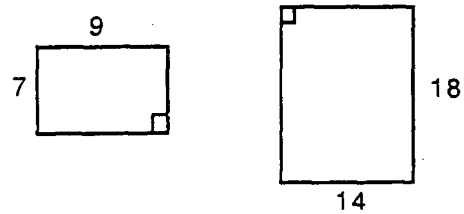
g° corresponds to ________

____

Working With Similar Figures

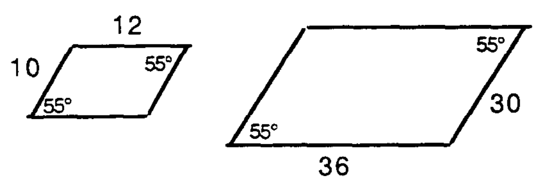
Is each pair of polygons similar? Circle yes or no. Use ratios to prove your answer.
(Hint: Cross multiply to see if the ratios are equal.)

1)



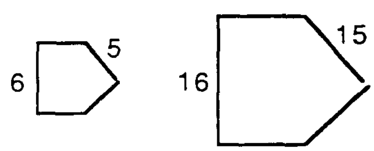
_____ = _____ Yes No

2)



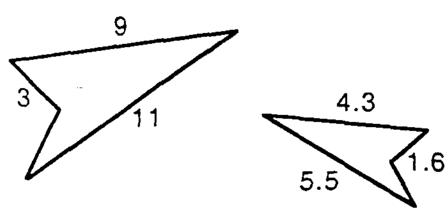
_____ = _____ Yes No

3)



_____ = _____ Yes No

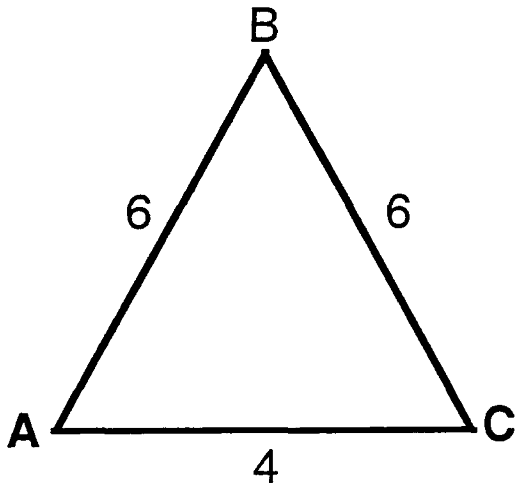
4)



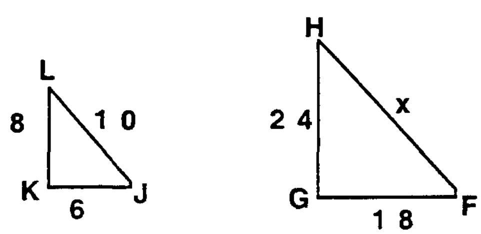
_____ = _____ Yes No

Transparency

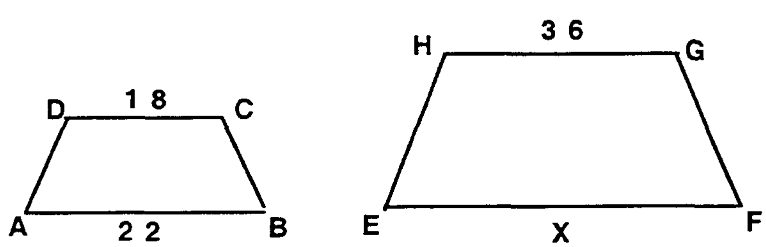
Similar Triangles



Solving Proportions with Similar Figures



______ = ______

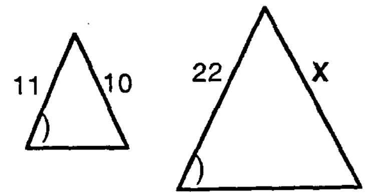


______ = ______

Name: ____________________

Finding the Missing Side

If polygons are similar
1) Corresponding angles are congruent.
2) Corresponding sides are proportional.



Because corresponding sides are proportional:
1) You can prove two figures are similar using ratios.
2) You can find a missing side:
   - write a proportion using ratios
   - cross multiply
   - solve for *x*

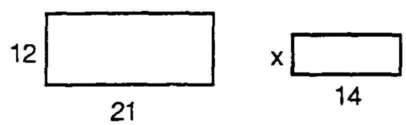
$$\frac{10}{11} = \frac{X}{22}$$

$$11x = 220$$

$$\frac{11x}{11} = \frac{220}{11} \qquad x = 20$$

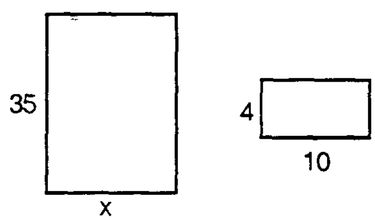
Find the missing length for the two similar figures in each problem.

1)



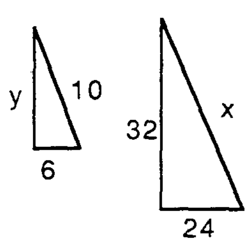
_____ = _____

2)



_____ = _____

3)



Find side X

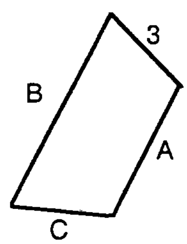
_____ = _____

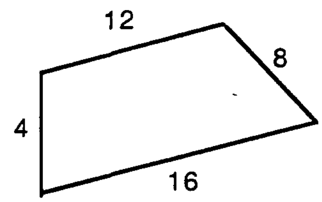
Find side y

_____ = _____

Find the Missing Side

4)

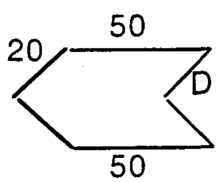


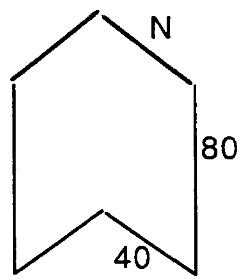


Find : Side A Side B Side C

_____ = _____ _____ = _____ _____ = _____

5)



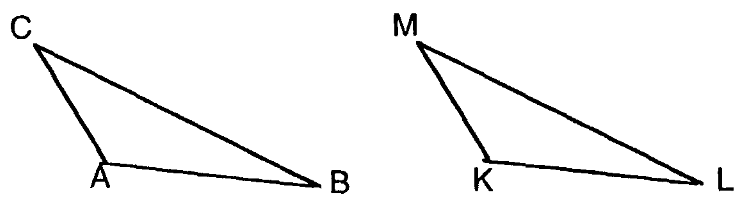


Find : Side N Side D

_____ = _____ _____ = _____

Congruent Figures ($\cong$) Δ ABC $\cong$ Δ DEF

* Match Exactly
* Same size
* Same shape



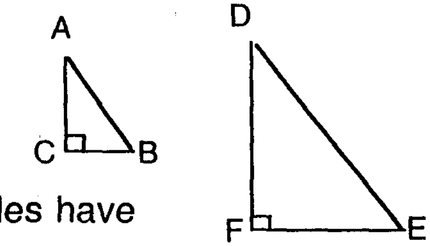
* Corresponding sides congruent

$\overline{AB} \cong \overline{KL}$
$\overline{BC} \cong \overline{LM}$
$\overline{CA} \cong \overline{MK}$

* Corresponding angles congruent

$\angle A \cong \angle K$
$\angle B \cong \angle L$
$\angle C \cong \angle M$

Similar Figures (~) Δ ABC ~ Δ DEF



* Same shape
* Different size
* Corresponding sides have the same ratio
* Use proportions to solve for unknown sides
* Corresponding angles congruent

$\angle C \cong \angle F$
$\angle B \cong \angle E$
$\angle A \cong \angle D$

* Corresponding sides **proportional**
Their ratios are equal.

$$\frac{\overline{AB}}{\overline{DE}} = \frac{16}{20} = \frac{4}{5}$$

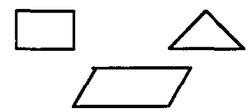
$$\frac{\overline{BC}}{\overline{EF}} = \frac{8}{10} = \frac{4}{5}$$

$$\frac{\overline{AC}}{\overline{DF}} = \frac{12}{15} = \frac{4}{5}$$

Name ____________________

Vocabulary Practice
Congruent and Similar Figures

Fill in the boxes in the following chart. For the box that says "phrases," write a few words that describe or define the vocabulary term. Think of as many ways as you can to explain the meaning of the vocabulary word. In the box that says "illustrations," draw a picture or pictures that represent the meaning of the term.

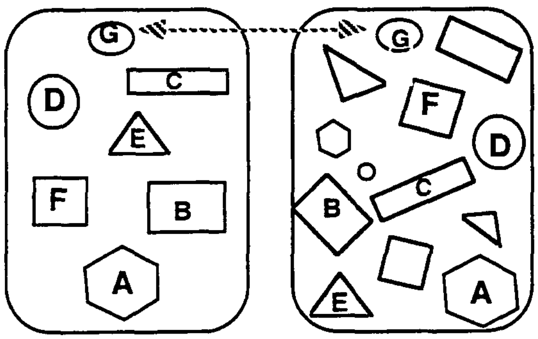
Vocabulary Term	Phrases	Illustrations
Polygon	• a closed figure • sides are all line segments	
Congruent		
Similar		
Corresponding		
Corresponding sides		
Corresponding angles		
Ratio		
Proportion		

Answer Key Objective 45

Congruent Figures

Circle the two figures - 1) b , d 2) c , e 3) a, e

Match up the congruent figures:



Congruent Polygons

1) $\overline{PR}$	4) <A	7) 48˚	10) 11 ft
2) $\overline{AB}$	5) <R	8) 32˚	
3) $\overline{CB}$	6) <Q	9) 19 ft	

page 2 Fill in the blanks 1) YZ 2) XY 3) ZX 4) <E 5) <F 6) <D

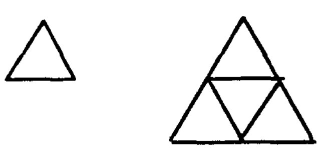
Find the corresponding sides and angles 1) $\overline{JK}$ 2) $\overline{KL}$ 3) $\overline{LM}$ 4) $\overline{MJ}$
5) <D 6) <B 7) <A 8) <C

Draw corresponding figures : Answers will vary.

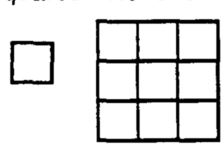
Building Similar Figures (Answers may vary)

Sample Pattern Block Figures

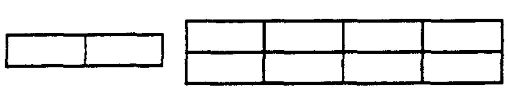
Triangles 1:2 ratio



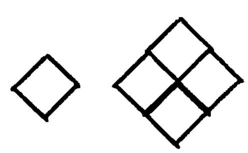
Squares 1:3 ratio



Rectangles 1:2 ratio



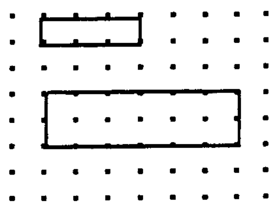
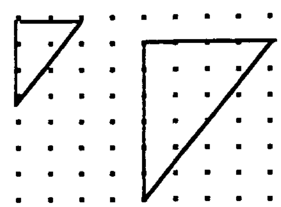
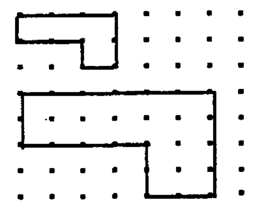
Rhombus 1:2 ratio



Similar Figures

Are these figures similar? No, Yes, No, Yes

Draw a similar figure: Double the length of each side.

Working With Similar Figures

Fill in: 1) 12 2) 15 3) 18 Ratio: 1:3 $\frac{4}{12} = \frac{1}{3}$ $\frac{5}{15} = \frac{1}{3}$ $\frac{6}{18} = \frac{1}{3}$

1) 15 2) 12 3) 18

More Practice with Similar Figures: 1) $\overline{CD}$ 2) $\overline{BC}$

2) 10, 6, 15, 4, 7, b°, a°, t°

page 2 : Is Each Pair of Polygons Similar?

1) yes $\frac{9}{18} = \frac{7}{14}$ $7 \times 18 = 9 \times 14$, $126 = 126$ or $\frac{9}{18} = \frac{1}{2}$ $\frac{7}{14} = \frac{1}{2}$

2) yes $\frac{12}{36} = \frac{10}{30}$ $36 \times 10 = 12 \times 30$, $360 = 360$ or $\frac{12}{36} = \frac{1}{3}$ $\frac{10}{30} = \frac{1}{3}$

3) no $\frac{6}{16} \neq \frac{5}{15}$ $6 \times 15 \neq 5 \times 16$, $90 \neq 80$ $\frac{6}{16} = \frac{3}{8}$ $\frac{5}{15} = \frac{1}{3}$

4) no $\frac{11}{5.5} \neq \frac{9}{4.3}$ $11 \times 4.3 \neq 9 \times 5.5$, $47.3 \neq 49.5$

Finding the Missing Side

1) $\frac{12}{x} = \frac{21}{14}$

$12 \times 14 = 21x$

$\frac{168}{21} = \frac{21x}{21}$

$8 = x$

2) $\frac{35}{10} = \frac{x}{4}$

$10x = 35 \times 4$

$\frac{10x}{10} = \frac{140}{10}$

$x = 14$

3) Side x

$\frac{x}{10} = \frac{24}{6}$

$6x = 24 \times 10$

$\frac{6x}{6} = \frac{240}{6}$

$x = 40$

Side y

$\frac{y}{32} = \frac{6}{24}$

$24y = 32 \times 6$

$\frac{24y}{24} = \frac{192}{24}$

$y = 8$

Answer Key - Find the Missing Side - page 2

4)

Side A

$$\frac{A}{12} = \frac{3}{4}$$

$4a = 12 \times 3$

$$\frac{4a}{4} = \frac{36}{4}$$

$a = 9$

Side B

$$\frac{B}{16} = \frac{3}{4}$$

$4b = 16 \times 3$

$$\frac{4b}{4} = \frac{48}{4}$$

$b = 12$

Side C

$$\frac{C}{8} = \frac{3}{4}$$

$4c = 8 \times 3$

$$\frac{4c}{4} = \frac{24}{4}$$

$c = 6$

4)

Side N

$$\frac{N}{20} = \frac{80}{50}$$

$50n = 80 \times 20$

$$\frac{50n}{50} = \frac{1600}{50}$$

$n = 32$

Side D

$$\frac{D}{40} = \frac{50}{80}$$

$80d = 50 \times 40$

$$\frac{80d}{80} = \frac{2000}{80}$$

$d = 25$

Objective 46: Investigate and apply the Pythagorean Theorem to find the missing length of a side of a right triangle.

Vocabulary

Pythagorean Theorem
hypotenuse
leg

Materials

Transparencies

- A Long Time Ago
- Using Your Calculator with the Pythagorean Theorem
- Pythagorean Theorem

Student Copies

- Grid Paper
- Exploring the Pythagorean Theorem
- Right Triangles and the Pythagorean Theorem
- Using the Pythagorean Theorem
- Review and Problem Solving with the Pythagorean Theorem
- Vocabulary Practice with the Pythagorean Theorem

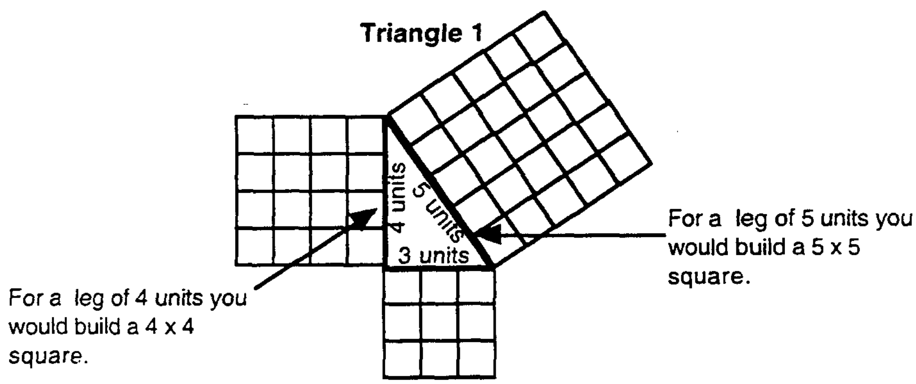
Language Foundation

1. Explain to students that some words in English have more than one meaning. One example is the word *leg*. It can mean the *leg* on your body, the *leg* of an animal, or the *leg* of a table. The word *leg* can also mean the *leg* of a pair of pants. Tell students that the word **leg** in math means the shorter sides of a right triangle.

2. The **Pythagorean Theorem** and **hypotenuse** will be taught in the context of the lesson.

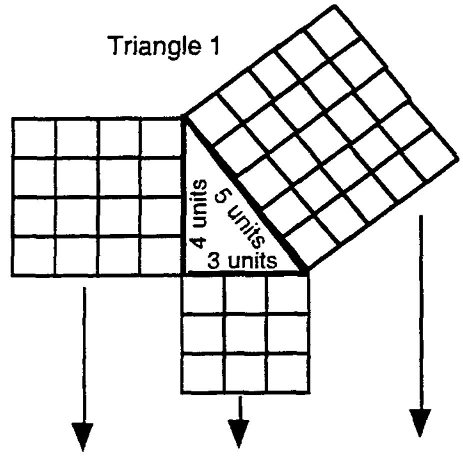
Mathematics Component

1. Explore the Pythagorean Theorem.
   - Place the transparency copy of A Long Time Ago on the overhead.
   - Read the information about the history of the **Pythagorean Theorem** aloud.
   - Distribute student copies of Grid Paper and Exploring the Pythagorean Theorem. (Note: There are 3 pages to this activity. Pages 2 and 3 may be run back-to-back.)
   - Tell students that they will be working on an activity to see if they can find the special relationship which Pythagoras discovered about right triangles.
   - Look at page one of Exploring the Pythagorean Theorem. Read the information given at the top of the page, reinforcing the terms **hypotenuse** and **legs.**
   - Point out the missing data on the chart. Tell students that they will fill in the data as they work on the activity. Then they will study the data to see if they can find a pattern.
   - Read the directions at the top of the second page aloud. Model using the grid paper provided to cut out and build a square on each of the legs of Triangle 1 as students do the same. For each of the three sides:
     - look at the number of units of length
     - identify the size of the square which can be built using that number of units
     - draw the appropriate square on a corner of the grid paper and cut it out
     - glue the square to the appropriate leg as shown below



   - Model filling in the missing information on the chart for Triangle 1. The column asking for the number of "units in the square" would be filled in for each leg and for the hypotenuse - 16 for the longer leg, 9 for the shorter leg, and 25 for the hypotenuse.
   - When students have completed the data on the three charts, ask them to study the data and talk with a partner to see if they can find a pattern. A place is provided on page 1 to write about any pattern they see. Have students share their ideas.
   - Lead students to understand that the square created by the length of the hypotenuse is equal to the sum of the two squares created by the lengths of the legs.
   - Reinforce this concept by going back to each of the triangles and illustrating as shown below.

- Show that if the sides were labeled a (longer leg), b (shorter leg), and c (hypotenuse), the relationship would be $a^2 + b^2 = c^2$.



16 units + 9 units = 25 units

$4^2 + 3^2 = 5^2$

$a^2 + b^2 = c^2$

- Write $c^2 = a^2 + b^2$ on the board and ask students if the Pythagorean Theorem may also be written this way. (Yes, it is the same equation, just written in a different order.)
- Summarize this information for students by writing the following on the board. It is recommended that students keep the definition of the Pythagorean Theorem and the above illustration in their math vocabulary notebook.

Pythagorean Theorem:

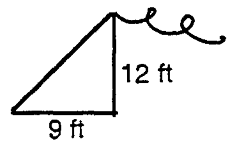
In any right triangle, the square of the length of the hypotenuse (c) is equal to the sum of the squares of the lengths of the legs (a and b).

$$a^2 + b^2 = c^2 \quad \text{or} \quad c^2 = a^2 + b^2$$

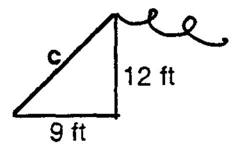
- The transparency Using Your Calculator with the Pythagorean Theorem is provided for instruction and review of calculator use.
- The activity sheet Right Triangles and the Pythagorean Theorem is provided for student practice.

2. Find the length of the **hypotenuse** of a right triangle using the Pythagorean Theorem.
   - Lead a discussion about kites. Show a kite and explain how it is used. Ask students if they have ever flown a kite and allow them to share any experiences.

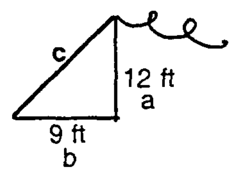
- Draw the following kite on the board.



- Ask students to name the shape of the kite. (It is a right triangle.)
- Show students that the length of two sides of the kite is given, but the other side is unknown.
- Ask students how they can find the length of the third side of the kite. Have them share ideas.
- Lead them to understand that if they know the lengths of two sides of a right triangle, they can use the **Pythagorean Theorem** to find the length of the third side.
- Ask students which side is the longest side. (In a right triangle the hypotenuse is the longest side.) Review how to find the **hypotenuse** and have a student label it **c**. (It is the side opposite the right angle.)



- Review that the other two sides of the triangle are called **legs**. Say, "Using the Pythagorean Theorem, we can label the legs as **a** and **b**. Which leg should be called side **a** ?" (It does not matter which leg is called **a** and which is called **b**.) Have a student come up and label the legs.

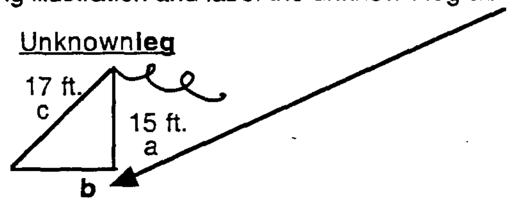


- Ask students what they know about this triangle using the Pythagorean Theorem. ($a^2 + b^2 = c^2$)
- Explain that they can substitute the values of **a** and **b** to find the length of the unknown side of the kite. Write the following and demonstrate substitution.

$$
\begin{aligned}
a^2 + b^2 &= c^2 \\
12^2 + 9^2 &= c^2 \\
144 + 81 &= c^2 \\
225 &= c^2
\end{aligned}
$$

- Point to side **c** and ask if 225 feet is the correct length for this side. (No) Lead students to understand that this is the value of **c** <u>squared</u>. If necessary, review the concept of square numbers and square roots introduced in the Numerical Reasoning unit.
- Say, "If 225 is c^2, how can we find the value of c?" (The value of c would be the square root of 225 which is 15. Students may use calculators.) Say, "The length of side **c** is 15 feet."
- The activity sheet <u>Using the Pythagorean Theorem</u> - Part 1 may be done for additional practice.

3. Find the length of a missing **leg** of a right triangle using the Pythagorean Theorem.
   - Tell students to think about the kite which was used in activity 2 above. Explain that this time, the kite is different. The length of the hypotenuse and one leg is given, but the length of the other **leg** is unknown. Draw the following illustration and label the unknown leg as **b**.



   - Ask students what expression they can write to represent the Pythagorean Theorem. Have a student write the expression on the board.

$$a^2 + b^2 = c^2$$

   - Point to the kite with the unknown leg. Ask students if they have <u>any</u> of the lengths they need to use the Pythagorean Theorem. (Yes, the length of leg **a** which is 15 ft. and the length of the **hypotenuse** which is 17 ft.)
   - Have one student come up and **substitute** the values of a and b in the equation.

$$a^2 + b^2 = c^2$$

$$15^2 + b^2 = 17^2$$

   - Have students simplify the expressions on both sides of the equation, using calculators as needed.

$$\begin{aligned} a^2 + b^2 &= c^2 \\ 15^2 + b^2 &= 17^2 \\ 225 + b^2 &= 289 \end{aligned}$$

   - Ask, "How can we find the value of b^2?" ($b^2 = 289 - 225$) Show the work to solve for b^2.

$$\begin{aligned} a^2 + b^2 &= c^2 \\ 15^2 + b^2 &= 17^2 \\ 225 + b^2 &= 289 \\ b^2 &= 289 - 225 \\ b^2 &= \sqrt{64} \\ b &= 8 \end{aligned}$$

   - Ask students if they noticed anything different about finding the length of a missing leg instead of the length of a missing hypotenuse. (Finding the length of a missing leg requires subtraction. Finding the hypotenuse only requires addition.)
   - The activity sheet <u>Using the Pythagorean Theorem</u> - Part 2 may be assigned for practice.
   - At the end of the lesson, <u>Review and Problem Solving with the Pythagorean Theorem</u> is provided for additional practice and reinforcement.

- A wall poster/review transparency Pythagorean Theorem has been included for further reinforcement of the Pythagorean Theorem.

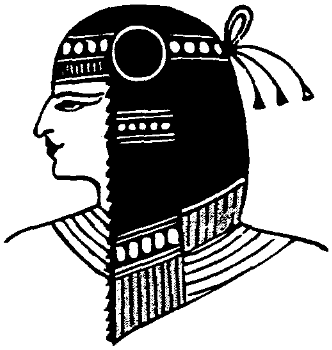
  Note: Before students begin the activity sheets, you may want to remind them that all square roots will not be whole numbers. Rounding decimals to the nearest tenth is one way to standardize answers.

Language Development Activities

- Vocabulary Reinforcement
  Have students complete the activity page Vocabulary Practice with the Pythagorean Theorem for additional reinforcement of the vocabulary in this lesson.

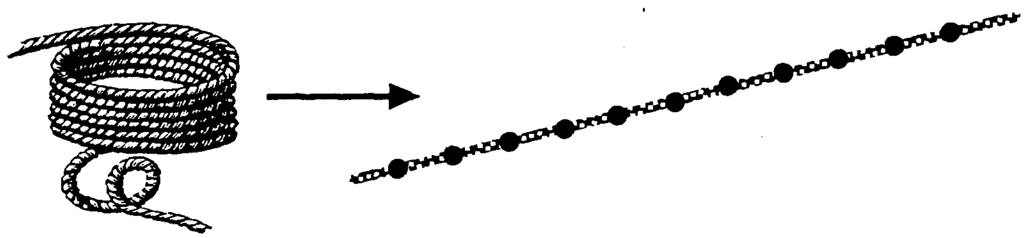
- Writing Prompt
  To reinforce the Pythagorean Theorem in students' minds, have them complete the writing prompt in Part III of the activity page Vocabulary Practice with the Pythagorean Theorem. Be sure students show the steps they would use to solve the problem.

A Long Time Ago

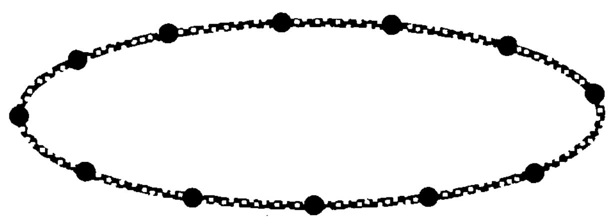


In ancient Egypt, farmers made fences to go around their fields. They tried to make square corners for their fields. Around 2000 B.C. they discovered something special about a fence built in the shape of a triangle.

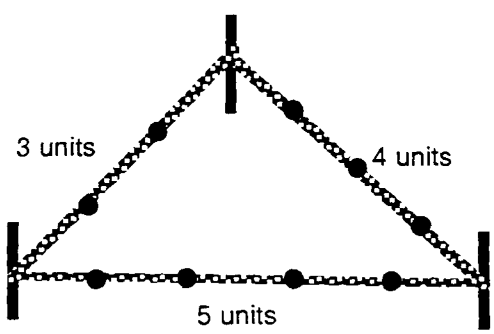
1. They knotted a rope into 12 equal spaces.



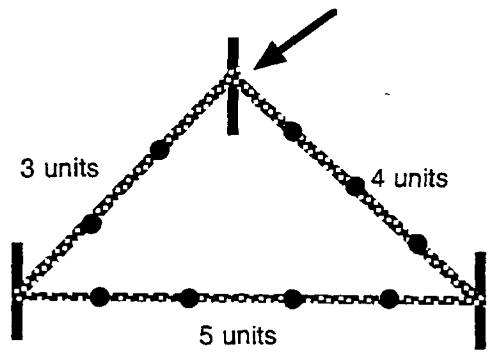
2. Then they tied the rope into a loop.



3. They put the rope around posts to make a fence. The sides were 3, 4, and 5 units long.



4. They discovered that the angle <u>opposite the longest side</u> was always a right angle. The right angle assured that they would always have a square corner in the field!



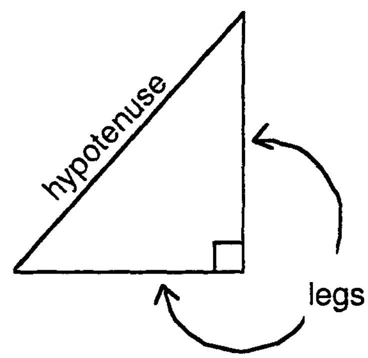
Later, the Greeks studied the same 3-4-5 right triangle. A Greek mathematician found a special relationship in this triangle. This relationship is named after the mathematician. His name was Pythagoras.

See if you can discover this special relationship in a 3-4-5 right triangle. It is called the **Pythagorean Theorem**.

Name ____________________

Exploring the Pythagorean Theorem

In a right triangle, the side opposite the right angle is always the longest side. It is called the **hypotenuse**. The two shorter sides are called the **legs**.



Fill in the missing data on the charts as you complete the activity on the next page.

Triangle 1	Units	Units in the square
Length of longer leg (a)	4	
Length of shorter leg (b)	3	
Length of hypotenuse (c)	5	

Triangle 2	Units	Units in the square
Length of longer leg (a)	8	
Length of shorter leg (b)	6	
Length of hypotenuse (c	10	

Triangle 3	Units	Units in the square
Length of longer leg (a)	12	
Length of shorter leg (b)	5	
Length of hypotenuse (c)	13	

Look at the completed data for all 3 charts. What pattern do you see?

____

____

____

____

____

____

____

____

____

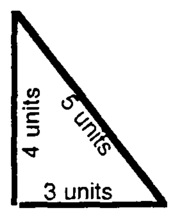
____

____

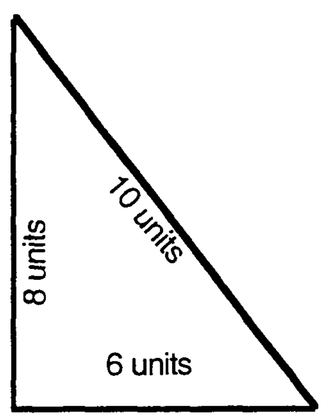
Name ______________________________

Use the grid paper provided to build a **square** on each of the legs of the triangles.

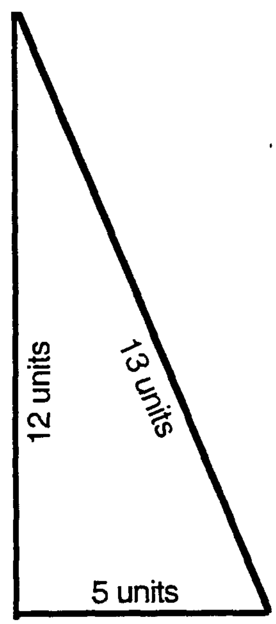
Triangle 1



Triangle 2



Triangle 3



Grid Paper

Using Your Calculator With the Pythagorean Theorem

You can use:

The SQUARE key $\boxed{x^2}$

and

The SQUARE ROOT key $\boxed{\sqrt{}}$

on your calculator to find the *hypotenuse* and missing *sides* (legs) of a right triangle when you work with the Pythagorean Theorem.

To square a number:

$b = 8$

$b^2 = 8\ \boxed{x^2} = 64$

To find the square root of a number:

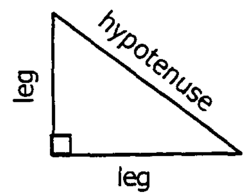
$c^2 = 169$

$c = \boxed{\sqrt{}}\ 169 = 13$

Name:____________________

Right Triangles and the Pythagorean Theorem

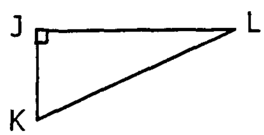
A Right Triangle



The ______________ is the longest side of a right triangle.

It is opposite the __________ __________ .

The two sides which form the right angle are called the ______ .



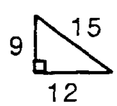
JK is a ______________

JL is a ______________

KL is the ______________

Identify the length of each leg and the hypotenuse in these right triangles.

a)

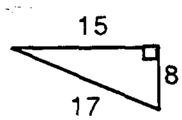


hypotenuse ____

leg ____

leg ____

b)



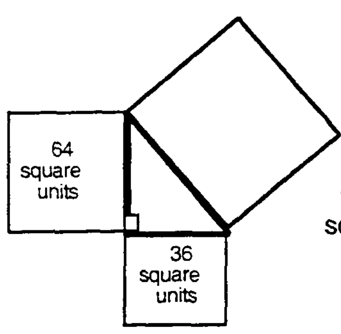
hypotenuse ____

leg ____

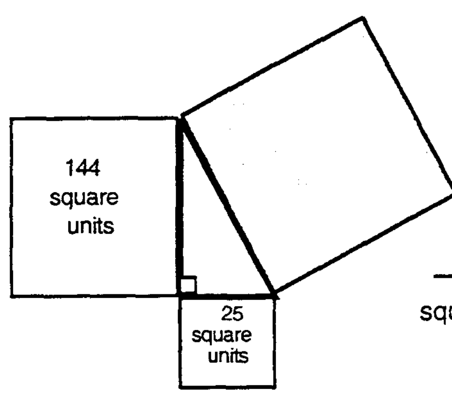
leg ____

How many square units are there in the shaded square?

(Remember: The area of the square on the hypotenuse equals the sum of the areas of the squares on the legs. $c^2 = a^2 + b^2$)

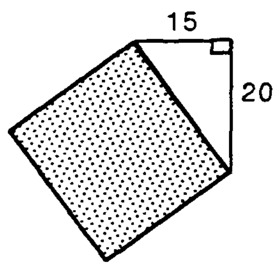


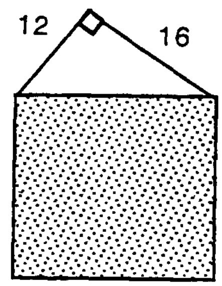
_____ square units



_____ square units

Find the area of the square.





Use the Pythagorean Theorem ($a^2 + b^2 = c^2$).
Fill in the blank with = or ≠ to make a <u>true</u> statement.

1) 6^2 ______ $4^2 + 5^2$

2) 5^2 ______ $3^2 + 4^2$

3) $11^2 + 8^2$ ______ 14^2

4) $12^2 + 35^2$ ______ 37^2

The lengths of the 3 sides of a triangle are given. Decide whether it is a right triangle. (Hint: If it is a right triangle, then $a^2 + b^2 = c^2$)

1) 7 cm, 24 cm, 25 cm

2) 3 ft, 14 ft, 6 ft

3) 10 m, 24 m, 26 m

4) 5 yd, 7 yd, 4 yd

5) 20 km, 29 km, 21 km

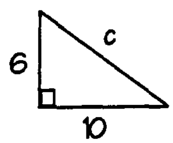
Name: ____________________

Using the Pythagorean Theorem

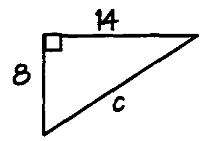
Part 1 - Finding the Hypotenuse

Find the length of the hypotenuse in each right triangle. Round to the nearest tenth.

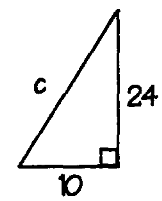
1)



2)



3)



Use the information below and the Pythagorean formula to find the length of the missing side. to the nearest tenth. Draw and label the triangle.

1) a = 9 b = 10 c = ?

2) a = 5 b = 12 c = ?

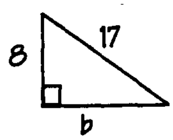
3) a = 9 b = 40 c = ?

4) a = 36 b = 75 c = ?

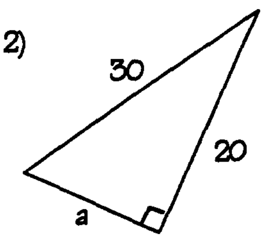
Part 2 - Finding the Leg of a Right Triangle

Find the length of the missing leg of the right triangle to the nearest tenth.

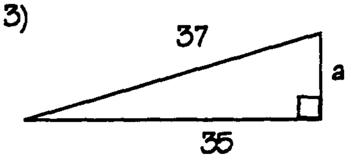
1)



2)



3)



Use the information below and the Pythagorean formula to find the length of the missing leg to the nearest tenth. Draw and label the triangle.

1) a = ? b = 6 c = 10

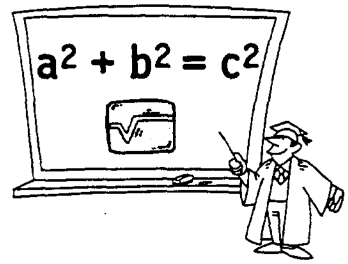
2) a = 32 b = ? c = 40

3) a = 18 b = ? c = 30

4) a = ? b = 8 c = 14

Name:____________________

Review and Problem Solving with the Pythagorean Theorem



Solve each equation.

1) $a^2 + 60^2 = 61^2$

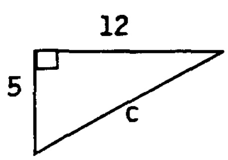
3) $12^2 + b^2 = 20^2$

2) $65^2 + b^2 = 97^2$

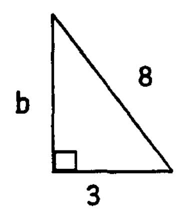
4) $36^2 + 77^2 = c^2$

Find the length of the missing side.

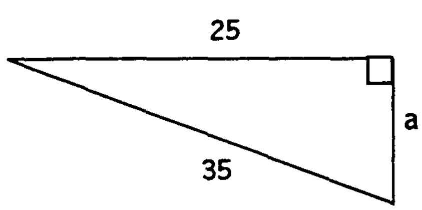
1)

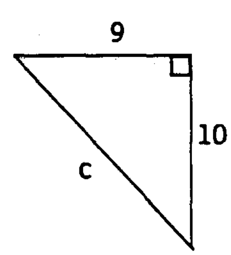


2)



3)





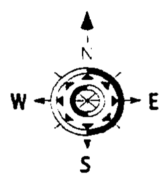
Problem Solving

Use right triangles and the Pythagorean theorem to solve these problems.

1) Draw and label a diagram to illustrate the problem.

2) Write the formula and show all your work.

1) Anita leaves school and walks four blocks north and then three blocks west. How far is Anita from the school?



2) Dad placed the bottom of a 30 ft ladder 18 ft out from a tree. How high up the tree does the top of the ladder reach?

3) Jin Yong wants to make a diagonal path through her garden. If her garden is in the shape of a rectangle 10 m by 24 m, how long will the path through the garden be?

4) Find the perimeter of the <u>right</u> triangle if $a = 8$ and $b = 15$.

Pythagorean Theorem

Wall Poster

Use the Pythagorean Theorem to:

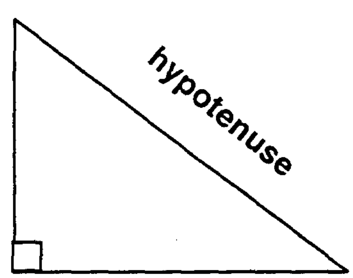
1) Find the length of a diagonal in a right triangle.

2) Find the length of any side of a right triangle if 2 sides are known.

3) See if a triangle is really a right triangle.

The Pythagorean Theorem says:

In a right triangle, the square of the length of the hypotenuse equals the sum of the squares of the legs.



Pythagorean Formula

$$a^2 + b^2 = c^2$$

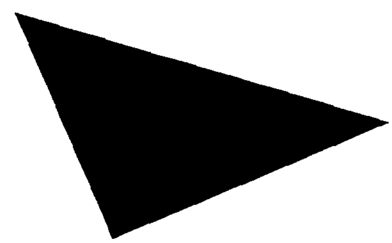
Name ____________________

Vocabulary Practice with the Pythagorean Theorem

Part I. Cloze. Read the following paragraph. Fill in the blank spaces with a word from the box.

In any ____________________ triangle, sides *a* and *b* are the ____________________ of the triangle that form the right ____________________. Side *c* is the ____________________, or longest side, of a right triangle. If you know the ____________________ of two sides of a right triangle, you can use the ____________________ theorem to find the length of the ____________________ side.

angle	right
hypotenuse	legs
length	third
Pythagorean	



Part II. True or False. Mark **T** on the line if the statement is *true*; **F** if it is *false*.

______ 1. The Pythagorean theorem can be used to see if a triangle is a right triangle.

______ 2. The side opposite the right angle is called the leg.

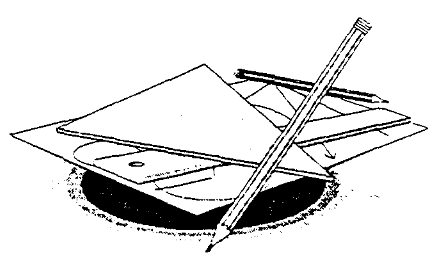
______ 3. The Pythagorean theorem can be used for an acute triangle.

______ 4. The relationship known as the Pythagorean theorem is true for any right triangle.

______ 5. In a triangle the square of the length of the hypotenuse is equal to the sum of the square of the lengths of the legs.

Part III. Writing Prompt

Create a word problem of your own where you would have to use the Pythagorean theorem. Illustrate your problem. Show the steps to solve the problem and explain the correct solution.



Answer Key
Objective 46

A Long Time Ago

Relationship - *The sum of the squares of the lengths of the two legs of a right triangle is equal to the* square of the length of the hypotenuse or $a^2 + b^2 = c^2$.

Exploring the Pythagorean Theorem

Triangle 1	Units	Units in the square
Length of longer leg (a)	4	16
Length of shorter leg (b)	3	9
Length of hypotenuse (c)	5	25

Triangle 2	Units	Units in the square
Length of longer leg (a)	8	64
Length of shorter leg (b)	6	36
Length of hypotenuse (c	10	100

Triangle 3	Units	Units in the square
Length of longer leg (a)	12	144
Length of shorter leg (b)	5	25
Length of hypotenuse (c)	13	169

Look at the completed data for all 3 charts. What pattern do you see?

For each of the triangles, $a^2 + b^2 = c^2$.

	Triangle 1	Triangle 2	
$a^2 \rightarrow$	16	64	144
$b^2 \rightarrow$	+9	+36	+25
$c^2 \rightarrow$	25	100	169

Right Triangles and the Pythagorean Theorem

A Right Triangle

The hypotenuse is the longest side of a right triangle.
It is opposite the right angle.
The two sides which form the right angle are called the legs.

JK is a leg.
JL is a leg.
KL is the hypotenuse.

Identify the length of each leg and the hypotenuse in these right triangles

a) hypotenuse 15
leg 9
leg 12

b) hypotenuse 17
leg 15
leg 8

Answer Key
Objective 46
(page 2)

How many square units are there in the shaded square?

<u>100</u> square units   <u>169</u> square units

Find the area of the square.

625   400

Fill in the blank with = or $\neq$ to make a true statement.

1) $\neq$ 3) $\neq$

2) =   4) =

Decide whether it is a right triangle.

1) yes
2) no
3) yes
4) no
5) yes

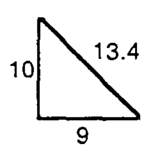
<u>Using the Pythagorean Theorem</u>

Find the length of the hypotenuse to the nearest tenth.

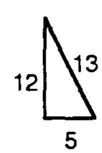
1) 11.7   2) 16.1   3) 26

Find the length of the missing side. Draw and label.

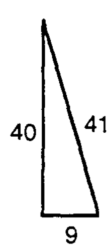
1) 13.4



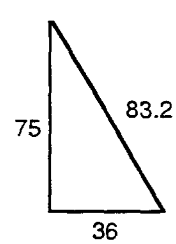
2) 13



3) 41



4) 83.2



Answer Key

Objective 46

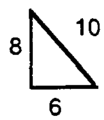
(page 3)

Find the length of the missing leg of the right triangle to the nearest tenth.

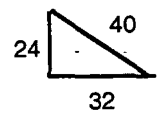
1) 15 2) 22.4 3) 12

Find the length of the missing leg to the nearest tenth. Draw and label the triangle.

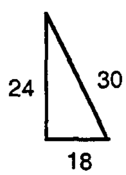
1) a = 8



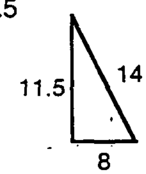
2) b = 24



3) b = 24



4) a = 11.5



Review and Problem Solving with the Pythagorean Theorem

1) a = 11 3) b = 16

2) b = 72 4) c = 85

Find the length of the side not given.

1) c = 13 2) b = 7.4

3) a = 24.5 4) c = 13.5

Problem Solving

1) 5 blocks 2) 24 feet

3) 26 feet 4) 40

Vocabulary Practice with the Pythagorean Theorem

Part I.

In any right triangle, sides a and b are the legs of the triangle that form the right angle. Side c is the hypotenuse, or longest side, of a right triangle. If you know the length of two sides of a right triangle, you can use the Pythagorean theorem to find the length of the third.

Part II.

1. T
2. F
3. F
4. T
5. T

Part III.

Answers will vary.

Objective 47: Identify and describe the characteristics of angles, including supplementary, complementary, vertical, and adjacent angles.

Vocabulary

ray
angle
right angle
obtuse angle
acute angle
straight angle
complementary angles
supplementary angles
vertical angles
adjacent angles
intersect
intersecting

Materials

protractors
brass fasteners

Transparencies:

Ray Templates
Vertical and Adjacent Angles
Review of Angles and Angle Pairs

Student Copies:

Ray Templates
Complementary and Supplementary Angles
More Practice with Complementary and Supplementary Angles
Working with Vertical and Adjacent Angles
All About Angles Angles - Review
Vocabulary Challenge - Angle Analogies
Vocabulary Practice - Angles

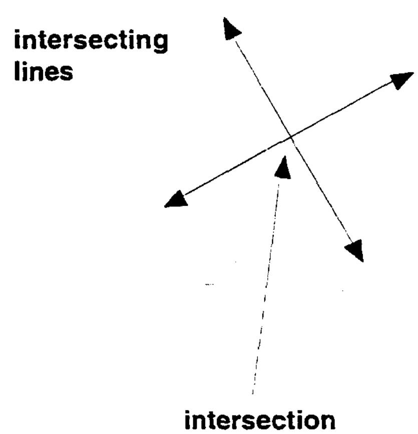
Language Foundation

1. Ask a student to name the person sitting next to him/her. Tell the class that ________ (name of student) is sitting **adjacent** to ________(name of student). Have students pronounce the word with you. Give students opportunities to talk about other objects in the room which are adjacent to something so that they may practice hearing and saying this word.

2. Ask if anyone knows what the noun **supplement** means. Use it in examples sentences such as "You can supplement your diet with vitamins. Some people supplement their income with a second job. There are a lot of supplements in the newspaper on Sundays." Lead students to understand that it means an addition to or an additional part.

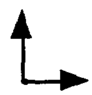
   Supplementary is an adjective used in this lesson to describe angles.

3. Have students describe an intersection at a traffic signal. The roads cross or **intersect** at the light. Tell them that in this lesson they will be working with lines that intersect or pass across each other.

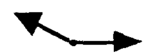


Mathematics Component

1. Review properties and classification of angles.
   - Give each student a copy of <u>Ray Templates</u> and a fastener. Have each student cut out the three rays and wait for further directions. (The teacher also needs to cut one out for demonstration on the overhead. Tagboard would be a good material to use if it is available.)
   - Review the definition of a **ray** (part of a line that starts at an endpoint and goes on forever in one direction).
   - Instruct each student to connect the two black rays together at their endpoints with the fastener.
   - Ask students what is created when two rays are joined at their endpoints (angle).
   - Review angle classifications with students, by having students move the paper rays to make the following angles:

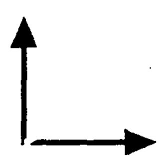
     right angles (90°) 

     acute angles (less than 90°) 

     obtuse angles (greater than 90°) 

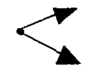
     straight angles (180°) 

2. Describe and create sets of complementary and supplementary angles.
   - Instruct students to connect the third ray to the other two rays and lay them on the table. (Add a third ray to the overhead set for demonstration.)
   - Tell the students to create a right angle with the two black angles.
   - Ask students to move the gray angle in between the two black rays. Demonstrate as shown below.

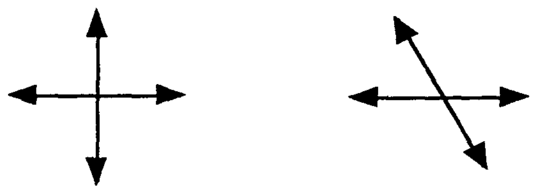


   - Explain that the gray ray breaks the right angle into two smaller angles that add up to 90°. Say, "These angles are called **complementary angles**. They add together to equal 90 degrees."
   - Show that the gray ray can be moved to create different sets of **complementary angles**. Use a protractor to prove that the sum of the angles is 90 degrees.
   - Have students move the two black angles to make a straight angle as shown below.
   - Then ask them to move the gray angle in between the two black rays.

- Explain that the gray ray breaks the straight angle into two smaller angles that add up to 180°. Say, "These angles are called **supplementary angles**. They add together to equal 180 degrees."
- Show that the gray ray can be moved to create different sets of **supplementary angles**.
- The activity sheets <u>Complementary and Supplementary Angles</u> and <u>More Practice with Complementary and Supplementary Angles</u> are provided for further practice.

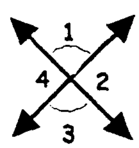
3. Introduce the idea of vertical and adjacent angles.
   - Remind students that two rays that join at their endpoints create an angle. 
   - Draw two intersecting lines on the overhead as shown.

Examples:

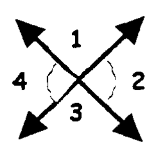


- Show students that these two lines come together or **intersect**.
- Ask what the two lines create when they **intersect**? (4 angles)
- Display the transparency <u>Vertical and Adjacent Angles</u> on the overhead. Uncover one set of intersecting lines at a time.
- Select individual students to come to the overhead and measure each of the four angles on the <u>first set</u> of intersecting lines. Record each measure. (This would be a good time to review the terms **acute angle** - an angle that is less than 90° " and **obtuse angle-** an angle that is more than 90° .)
- Ask students to describe what they see. [Opposite angles (1 & 3 and 2 & 4) are equal in measure or congruent.) Explain that these angles which are across from each other are called **vertical angles**.

<u>Vertical Angles</u>



Angle1 and angle 3 are vertical angles.

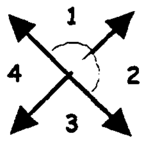


Angle2 and angle 4 are vertical angles.

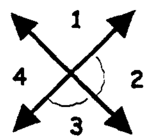
- Ask students if they think that vertical angles will always be the same measure. (Yes)
- Use the second set of intersecting lines to determine if this relationship occurs again. (Yes)
- Ask the students to verbalize the relationship between **vertical angles.** (Vertical angles are equal in measure.)
- Point to two angles which are side-by-side. Tell students that these are called **adjacent angles**.

- Point to two angles which are side-by-side. Tell students that these are called **adjacent angles.** Say, " **Adjacent** means next to each other."

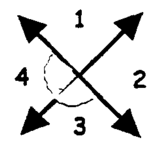
Adjacent Angles



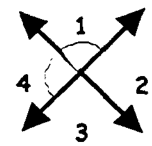
Angle 1 and angle 2 are adjacent angles.



Angle 2 and angle 3 are adjacent angles.



Angle 3 and angle 4 are adjacent angles.



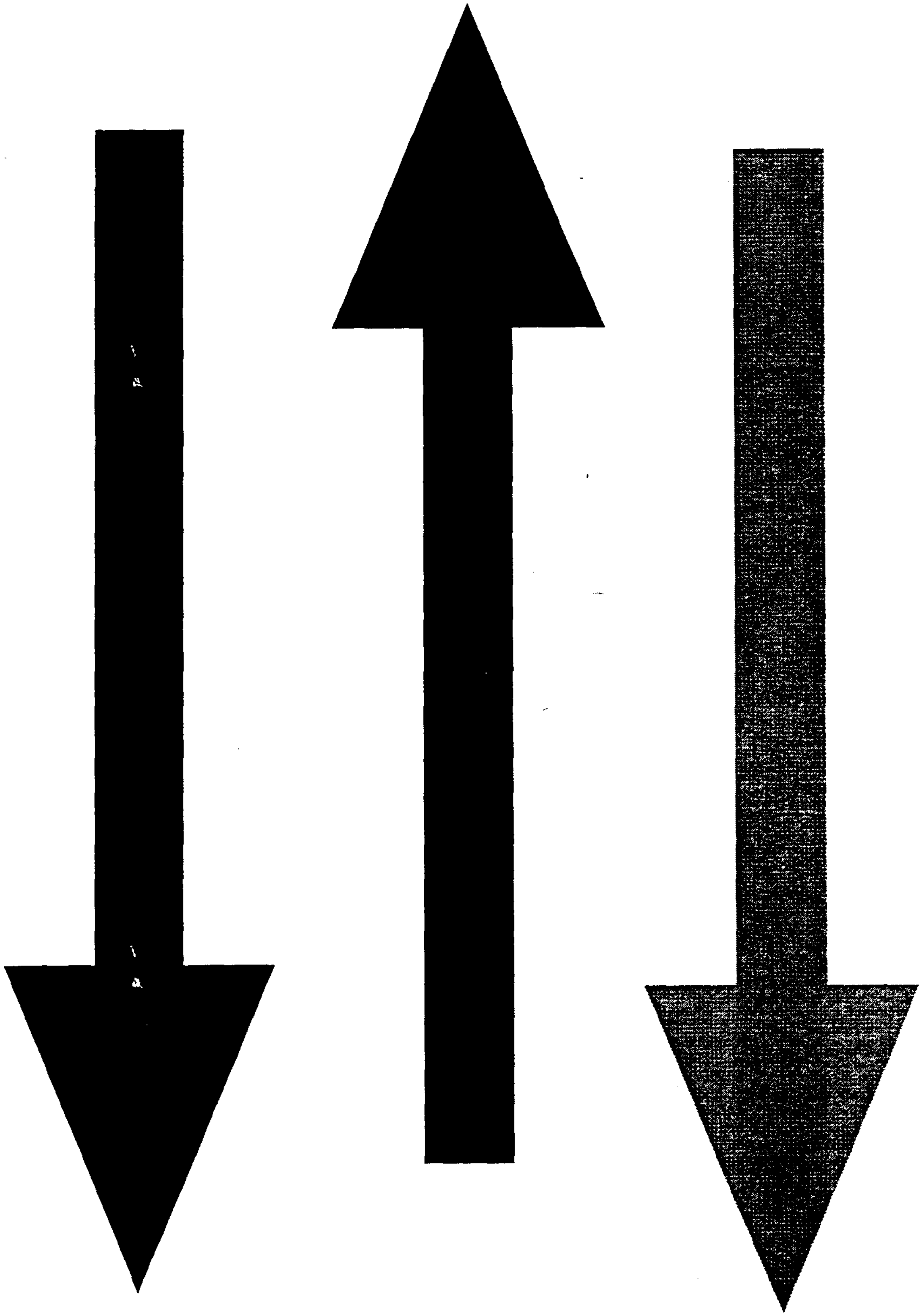
Angle 4 and angle 1 are adjacent angles.

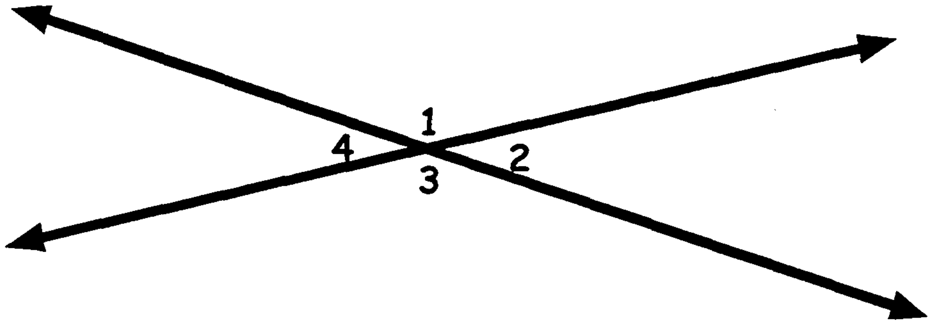
- Ask students what they notice about the measure of adjacent angles formed by two intersecting lines. (They add together to equal 180 degrees.) Tell students that since they add together to equal 180°, these adjacent angles are also called supplementary angles.
- Display the third set of intersecting lines.
- Ask students if they can determine the measure of the other three angles without using a protractor. (Angle 3 and the one given as 140° are **vertical** so angle 3 is 140° also. Angle 4 is **supplementary** to the one given so it must equal 40 ° so that the two together equal 180 °. Angle 2 is **supplementary** to angle 3 so it must be 40° so that they equal 180°.)
- The activity sheets Working with Vertical and Adjacent Angles and All About Angles - Review are provided for further practice. The students will need a protractor to complete All About Angles - Review.
- The transparency/poster Review of Angles and Angle Pairs is included for students to keep in their notebooks, as a teacher review tool, or for classroom display.

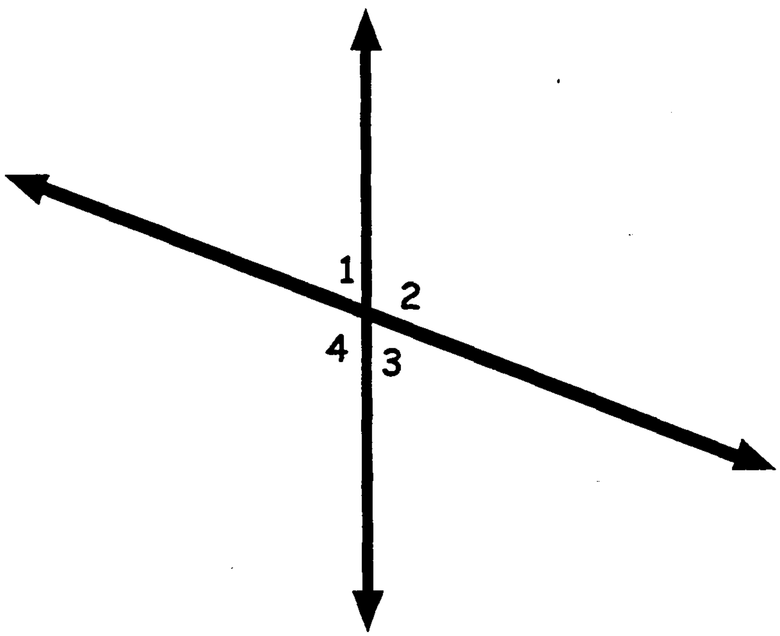
Language Development Activities

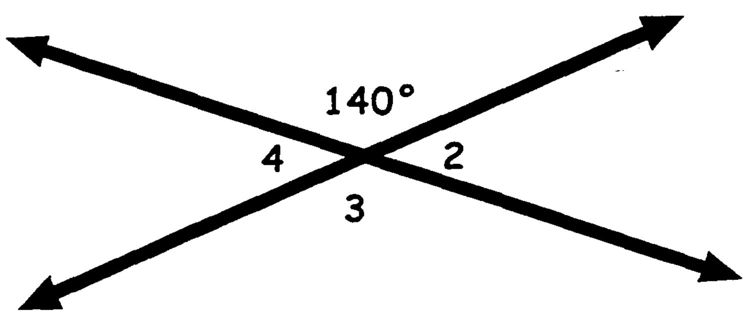
- The activity sheet Vocabulary Challenge - Angle Analogies will provide students practice reading and writing analogies using the angle vocabulary covered in the lesson.
- Vocabulary Practice - Angles can be used as a student dictionary of terms for Obj.47. It may be completed as a review sheet at the end of the unit or used to record and define terms as they are introduced in the lesson.

Ray Templates




1
4
2
3

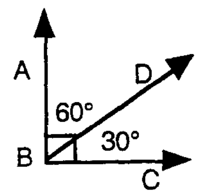

1
2
4
3


140°
4
2
3

Name ____________________

Complementary and Supplementary Angles

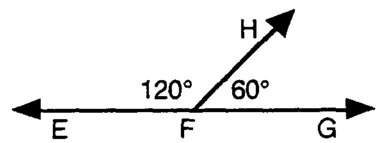
If the sum of the two angles is 90°, the angles are **complementary angles.**



30° + 60° = 90°

<ABD is the complement of <DBC

If the sum of the two angles is 180°, the angles are **supplementary angles.**

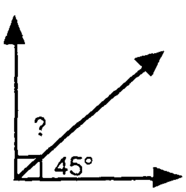


120° + 60° = 180°

<EFH is the **supplement** of <HFG

Find the measure of the complementary angle in each problem.

1)



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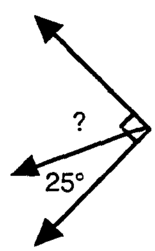
2)



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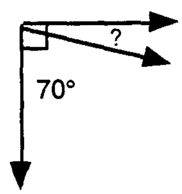
3)



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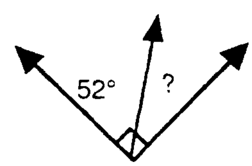
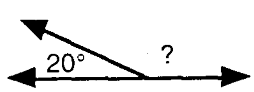
4)



____

Find the measure of the supplementary angle in each problem.

1)



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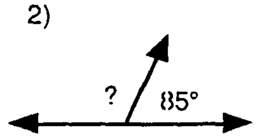
2)



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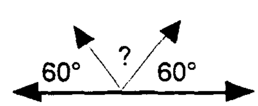
3)



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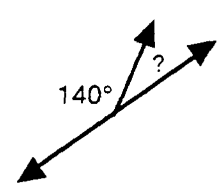
4)



____

Name:________________

Complementary and Supplementary Angles

Find the complement of each angle. Follow the example and show your work.

Example: 20° ⟶ 20° + ? = 90°
20° + **70°** = 90°
The complement of 20° is 70°.

1) 30° 2) 18° 3) 80°

4) 4° 5) 75° 6) 24°

Find the supplement of each angle. Follow the example and show your work.

Example: 20° 70° + ? = 180°
70° + **110°** = 180°
The supplement of 70° is 110°.

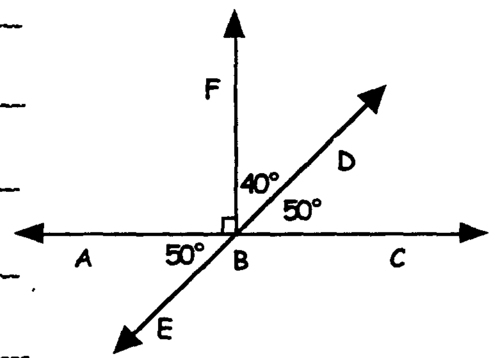
1) 50° 2) 81° 3) 165°

4) 106° 5) 15° 6) 90°

Name:____________________

More Practice with Complementary and Supplementary Angles

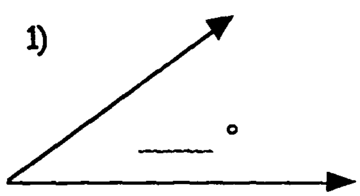
Write *true* or *false*.



1. <FBD and <DBC are complementary angles. ______
2. <FBD and <ABE are complementary angles. ______
3. <FBA and <FBC are complementary angles. ______
4. <DBC and <CBE are complementary angles. ______
5. <DBC and <ABE are complementary angles. ______
6. <ABF and <FBC are supplementary angles. ______
7. <DBC and <CBE are supplementary angles. ______
8. <FBC and <EBC are supplementary angles. ______

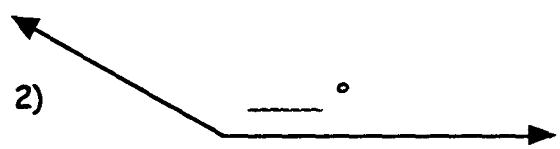
Measure each of the angles below with a protractor.
Find the complement and supplement of each angle without a protractor.

1)



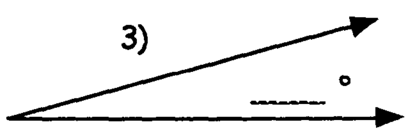
complement ______
supplement ______

2)



complement none(why not?)
supplement ______

3)

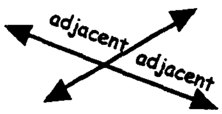


complement ______
supplement ______

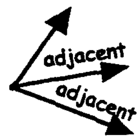
Name:______________________

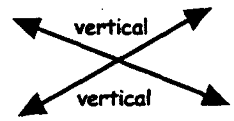
Working with Adjacent and Vertical Angles

Remember: When two lines intersect, they form angles that are adjacent and vertical.



or

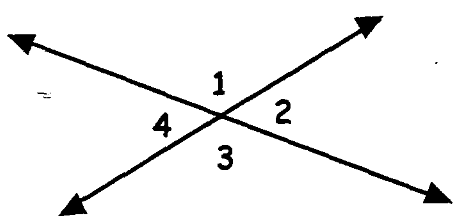




Adjacent angles =
*Two angles next to each other

Vertical angles =
*Two angles across from each other
* Always have the same measure
* Think V for <u>v</u>ertical

Use the figure below to answer the questions.



1) Name the pair of obtuse vertical angles. ∠______ and ∠_______

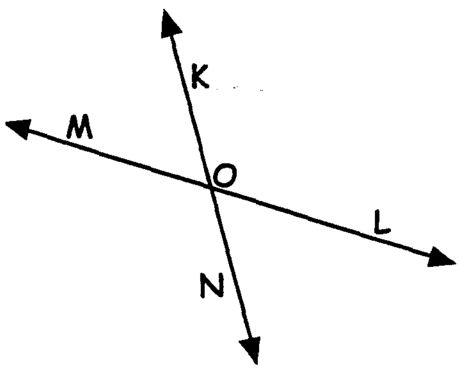
2) Name the pair of acute vertical angles. ∠______ and ∠_______

3) If <2 = 55°, then <4 = ______ ∠3 = ______ ∠1 = ______

4) If <1 = 135°, then <2 = ______ ∠4 = ______ ∠3 = ______

Working with Adjacent and Vertical Angles

Use the drawing below to answer the questions.



1) Use a protractor to measure <MOK

<MOK = ______°

2) Name the two pairs of vertical angles:

<______ and <______

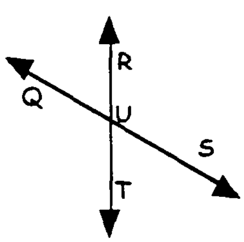
<______ and <______

3) Find the degree measures of <NOL , <KOL, and <NOM. Do not use a protractor.

<NOL = ______° <NOM= ______°

<KOL = ______°

Use the drawings below to answer the questions.



1) Name an angle adjacent to <RUS. <__________

2) Name a pair of adjacent angles. ______ and ______

Which angle is acute? < ______ Which is obtuse? <______

3) <QUT = 110°. What is the measure of <TUS? ______°

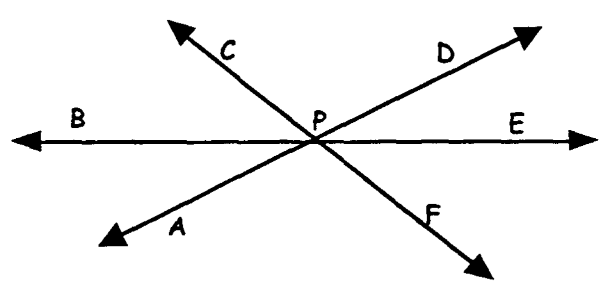
1) Name two angles adjacent to <EPF

______ ______

2) Name two angles adjacent to <CPD

______ ______

3) <BPA + <APF + < FPE = ______°

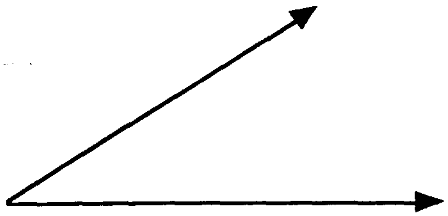


Name ____________________

All About Angles - Review

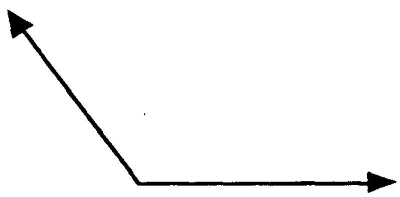
Use a protractor to measure the given angle. Draw a complementary angle. Label each angle with its measurement in degrees.

1.



Use a protractor to measure the given angle. Draw a supplementary angle. Label each angle with its measurement in degrees.

2.



Find the complement of each angle measure.

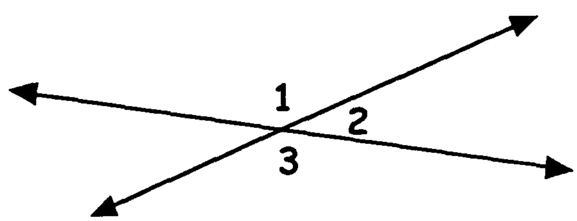
3) 22° _____ 4) 84° _____ 5) 18° _____

Find the supplement of each angle measure.

6) 15° _____ 7) 110° _____ 8) 153° _____

Use the diagram to find each angle measure.

9) < 1 = _____
10) < 2 = _____
11) < 3 = _____



12) Draw a set of vertical angles. Use a protractor to measure each angle. Label each angle with its measure in degrees.